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AIRPORT QUOTAS AND PEAK HOUR PRICING: ANALYSIS OF AIRPORT NETWO--ETC(U)
JUN 76 W R FROMME, W M SWAN

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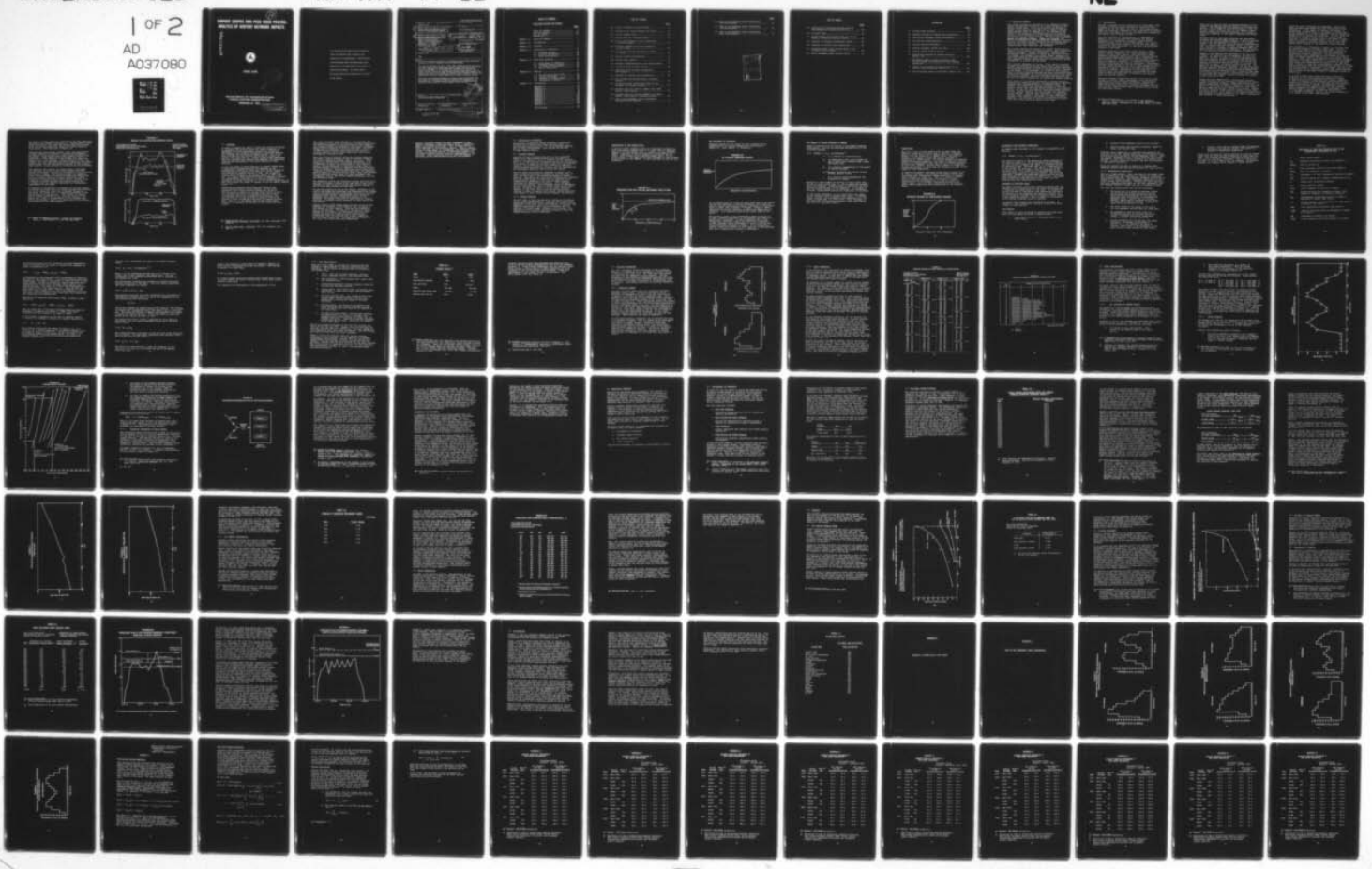

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AIRPORT QUOTAS AND PEAK HOUR PRICING: ANALYSIS OF AIRPORT NETWORK IMPACTS

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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WASHINGTON, D.C. 20591

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Technical Report Documentation Page

1. Report No. FAA AVP-77-5 12	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle (6) Airport Quotas and Peak Hour Pricing: Analysis of Airport Network Impacts.		5. Report Date (11) Jun 76
		6. Performing Organization Code
7. Author(s) (10) William R. Fromme, William M. Swan		8. Performing Organization Report No. (12) 171p.
9. Performing Organization Name and Address Office of Aviation Policy Federal Aviation Administration Department of Transportation Washington, D.C. 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address SAME (14) FAA-AVP-77-12		13. Type of Report and Period Covered (9) FINAL REPORT.
		14. Sponsoring Agency Code FAA (AVP-210)

15. Supplementary Notes

NONE

16. Abstract

This report provides an evaluation of the impacts of airport quotas and peak-hour pricing on air traffic congestion and airport system delay.

This analysis addresses two issues. First, would a schedule of peak-load pricing and quotas reduce airport system delays? Second, would a schedule of peak-pricing and quotas complement the system improvements provided by the technological features of the UG3RD? It is concluded, as a result of this analysis, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD by relieving aircraft congestion and delay and improving the flow of air traffic between the 25 largest air carrier airports.

While there are theoretical advantages to pricing and quota alternatives, there are economic and institutional constraints limiting their implementation on a widespread scale. Included among these constraints are the unresolved issues which might confront the FAA, airport sponsors, and the airlines.

D D C
MAR 16 1977

17. Key Words Peak Pricing, Auotas Airport Capacity and Delay Non-Capital Alternatives		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 138	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

406648.

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1.0 Executive Summary

This report provides an evaluation of the impacts of airport quotas and peak-hour pricing on air traffic congestion and airport system delay. It is the second of two analyses of quotas and peak-pricing undertaken by the Federal Aviation Administration (FAA) in response to a 1974 request by the Office of the Secretary of Transportation for a review of specific policy alternatives to the Upgraded Third Generation Air Traffic Control System (UG3RD). The first report, Airport Quotas and Peak-Hour Pricing: Theory and Practice, FAA AVP-77-5, examined the leading theoretical studies of peak-hour pricing and airport quotas, comparing and contrasting theory with the real-world situation. The potential problems of implementation were identified and discussed.

This report computes and compares air traffic delays anticipated at the 25 largest air carrier airports under alternative airport development strategy assumptions. Airport delays anticipated under a schedule of quotas and peak-hour pricing, for example, are compared to projected delays, assuming airports were equipped with UG3RD technological improvements and also compared to delays associated with a peak-pricing system implemented in concert with the UG3RD.

This analysis addresses two issues. First, would a schedule of peak-load pricing and quotas reduce airport system delays? Second, would a schedule of peak-pricing and quotas complement the system improvements provided by the technological features of the UG3RD? It is concluded, as a result of this analysis, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD by relieving aircraft congestion and delay and improving the flow of air traffic between the 25 largest air carrier airports.

While there are theoretical advantages to pricing and quota alternatives, there are economic and institutional constraints limiting their implementation on a widespread scale. For example, the optimum fare schedule necessary to shift air carrier traffic away from peak demand periods is not presently known. Nor have all the possible issues which might confront the FAA, airport sponsors, and the airlines been satisfactorily resolved. Perhaps, more importantly, a peak-pricing strategy would represent a departure from the traditional concept of free access to the nation's airspace system and services. The realities of peak-pricing and quota alternatives limit their practical value at this time.

2.0 Introduction

The FAA is engaged in major Engineering and Development (E&D) programs to provide new and improved air traffic control capabilities for the 1980's and 1990's. When these developments are completed, implemented, and integrated with existing facilities, the result will be the "Upgraded Third Generation Air Traffic Control System (UG3RD)."

The Under Secretary of Transportation, by memorandum of March 13, 1974, to the Assistant Secretary for Systems Development and Technology, requested a comprehensive technical review of the entire UG3RD program. As a result of the Under Secretary's request, the FAA has been asked to undertake economic evaluations of technical and operational features of the UG3RD.

Technical features of the UG3RD include Aerosat, Flight Service Station Automation, Wake Vortex Avoidance (WVAS), Airport Surface Traffic Control, Area Navigation (RNAV), Microwave Instrument Landing System (MLS), Discrete Address Beacon System/Intermittent Positive Control (DABS/IPC), and automation. 1/ In addition to these technical features, there are numerous noncapital, or relatively low-capital, program alternatives that might be introduced. The question has been raised whether or not two of these noncapital alternatives--peak-load landing fees and airport quotas--would complement technical features of the UG3RD and improve the flow of air traffic. The purpose of this research is to evaluate quotas and peak-pricing, and determine the impact these alternatives might have on congestion and delay at major air carrier airports.

The basic concept of peak-load pricing is the use of higher charges on aircraft (and/or passengers) during periods of high demand to control airport congestion. Theoretically, users confronted with a peak-time pricing schedule will redistribute their demand more uniformly throughout the day, with only the highest valued users receiving service during the peak-demand period.

1/ Each of these systems is described in The National Aviation System, Challenges of the Decade Ahead, 1977-1986 DOT, FAA, 1976.

There are at least two well documented examples in which airports have imposed peak-hour charges to alleviate congestion. One of these is at Heathrow Airport, where the British Airport Authority (BAA) in 1971 imposed a peak-period surcharge on aircraft operations in an attempt to alleviate congestion in the airport terminals and access roads.

Although there is some data indicating the peak-period surcharge has shifted demand slightly, it has not resulted in any major redistribution of traffic. It is noted, however, that the Heathrow peak-time charge (approximately $100) is imposed upon air carriers, which, as a group, are less sensitive to changes in operating expenses than are other sectors of the aviation community. This may account for the negligible impact of peak charges at Heathrow.

Results of the peak-pricing experiment at New York City airports, the second of the two examples, are more pronounced. In 1968, in order to alleviate congestion and make more capacity available for air carrier operations, the Port Authority of New York imposed a $25 fee for all landing and take-offs during peak hours by aircraft with less than 25 seats. The normal landing fee was $5. The impact of the surcharge was immediate. For the three major New York airports--Kennedy, LaGuardia, and Newark--general aviation activity during high-activity hours dropped over 30 percent from pre surcharge levels, indicating that peak-time landing fees can result in significant redistribution of particular user demands (general aviation) at a given airport and time of day.

Quotas and other administrative alternatives typically involve some form of fiat rationing to restrict air traffic access to congested airports. These restrictions may be applied selectively on specific categories of aviation; they may be in force only for certain periods of a day; and/or apply to some, but not all, runways of an airport. Banning of general aviation flights from an airport, or from some part of an airport, is an example of an administrative option. Establishment of a quota system for all users is perhaps the most familiar of these alternatives.

Quotas are easy to describe and comprehend. Their first-order and short-term effects are also straightforward and predictable: as the number of flights at an airport is reduced (due to quota limits on the number of flights that can be scheduled or to a ban on specific types of operations), congestion at an airport also decreases. In fact, since the relationship between airport demand and airport delay is nonlinear, a carefully chosen limit on the number of operations at a severely congested airport may lead to a significant reduction in the cost of delays, with a less than proportionate decrease in the number of flights allowed.

This phenomenon is illustrated in Figure 2.1, for year 2000 air carrier forecasts at Chicago O'Hare (ORD). The two demand curves shown in this figure represent projected air carrier traffic levels before and after the imposition of hypothetical quotas on operations. As explained later, these forecasts were developed for this analysis to test the impact of airport capacity constraints on air traffic delay. Figure 2.1 shows that a daily quota of 1,875 aircraft movements represents a 15 percent reduction in the number of ORD operations which might otherwise be anticipated in the year 2000. Delay, however, is more than proportionately reduced 53 percent, from the pre quota level of over 44,000 minutes each day to less than 21,000 minutes. Furthermore, the forecast indicates that more extensive use of wide-body aircraft under quota conditions would provide for equivalent numbers of passengers carried in either case.

It is little wonder that quotas have been particularly attractive to the various responsible bodies as a means of dealing swiftly and effectively with airside congestion. In 1969, for example, the FAA imposed hourly quotas on the scheduling of operations at the three New York City airports, O'Hare International in Chicago, and Washington National. These quotas have been generally credited for relieving traffic congestion at these airports. Developments since 1969 have made it possible to eliminate the quota at J. F. Kennedy and Newark. However, the system continues to be in effect at the other three airports.

The theory of these noncapital alternatives has been adequately reviewed in the economic literature. 2/ Previous efforts have shown convincingly that peak-time landing fees and/or quotas at an air carrier airport can reduce air traffic delays at that station. This was shown in Figure 2.1.

Questions have been raised, however, about the applicability of these findings to a network of airports where capacity constraints at one facility may induce ripple effects across the system. These ripple effects may aggrevate traffic congestion at other stations in the network such that total system delay is not improved. Airport quotas at O'Hare, for example, may force some eastbound traffic departing Los Angeles International into the peak activity periods of that airport. Other possibly counter productive situations can be envisioned.

This analysis looks beyond the single airport environment and addresses the issue of peak-pricing/quotas and total airport system delay, focusing on the network of the 25 largest air carrier airports. The analysis answers two questions. First, would a schedule of quotas and peak-time landing fees at the 25 primary large hub airports relieve air traffic congestion and reduce airport system delays? Second, would a schedule of quotas and peak-time landing fees at the 25 primary large hub airports complement the technological improvements of the UG3RD?

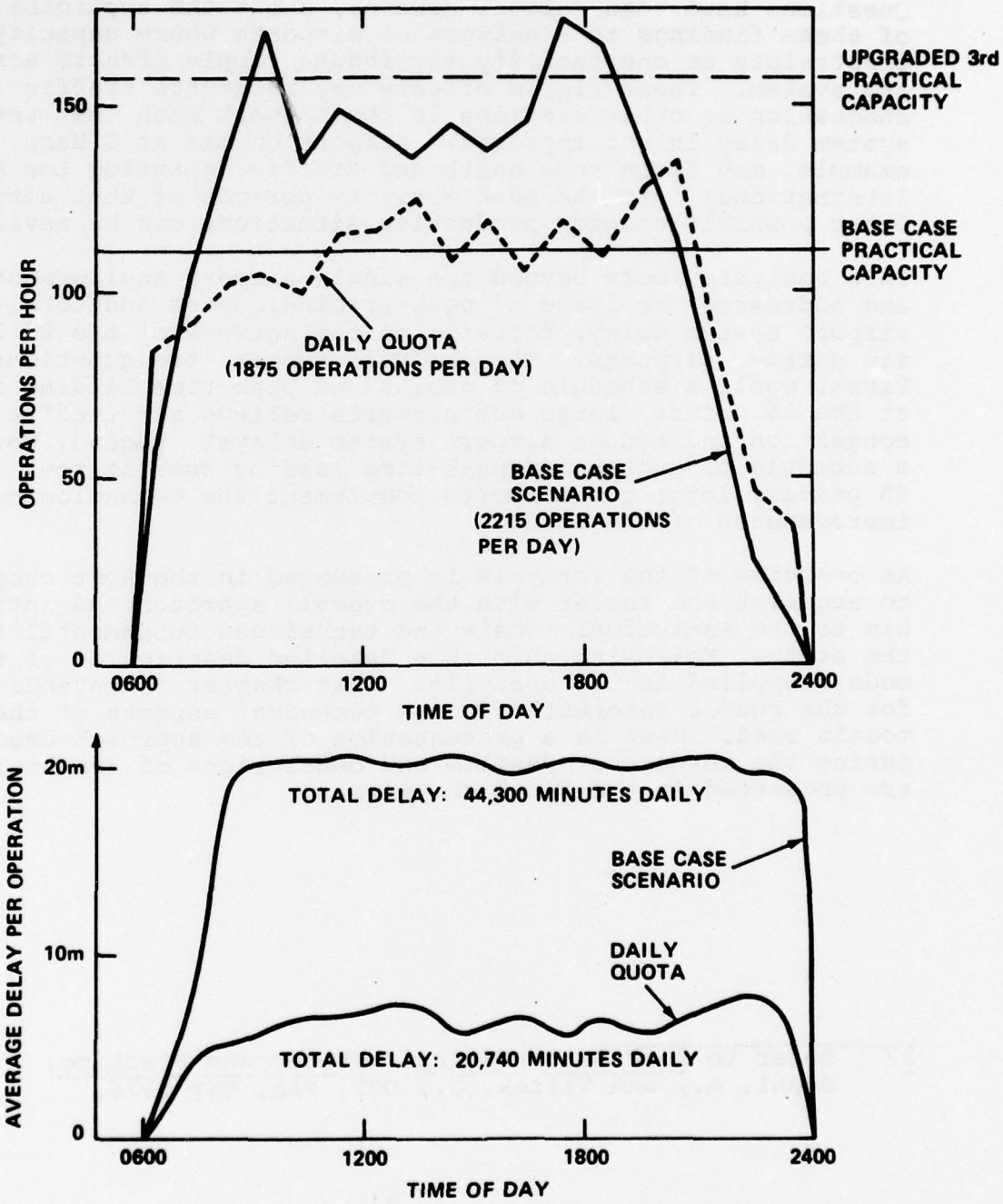
An overview of the analysis is presented in the next chapter to acquaint the reader with the overall approach and introduce him to the analytical models and techniques fundamental to the study. Following this is a detailed description of the models applied in the analysis. This chapter is intended for the reader interested in the technical aspects of the models used. Next is a presentation of the approach used during the research. Results and conclusions of the analysis are presented in the final chapters.

2/ Refer to Peak-Load Pricing: Theory and Practice, Odoni, A., and Vittek, J., DOT, FAA, May 1976.

FIGURE 2.1
IMPACT OF QUOTAS ON AIRPORT DELAY

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

CHICAGO O'HARE
TRAFFIC FORECAST
YEAR 2000



3.0 Overview

In order to examine the impact of peak-time pricing and quotas on congestion and delay at major air carrier airports, an experiment with four operational scenarios or situations was designed, each scenario representing a different development strategy for the national airport system. Two of the scenarios employed peak pricing and quotas to relieve congestion, the others did not. Airport system delays associated with each scenario were computed and compared, and differences observed were attributed to the unique features of each scenario.

To test the impact of these scenarios on airport system delay, a mathematical programming model was developed at the Massachusetts Institute of Technology (MIT) Flight Transportation Laboratory to represent the network of the 23 largest metropolitan air carrier centers or hubs. The analysis of airport delays focused on the primary airport in each large hub. As a group, these airports--listed in Appendix A--account for approximately 70 percent of all national passenger enplanements and almost 40 percent of all air carrier operations. 1/ They also account for almost 75 percent of all air carrier airport delays. 2/

Simulating the planning and routing activities of the United States domestic airline industry, the MIT fleet assignment model routed aircraft through the system of 243 city pairs or markets to provide either direct or multistop aircraft services to the primary large hub airports in accordance with a set of optimization criteria. For this analysis an airline strategy to maximize profits was adopted in order to provide a realistic air carrier environment. That is, it was assumed the airlines would behave rationally to maximize net revenues on the routes they were flying.

1/ Terminal Area Forecast, 1976-1986, DOT, FAA, September 1974, Table II.

2/ Airline Delay Data, 1970-1974, DOT, FAA, February 1975, page 22.

The fleet assignment model applied in this analysis takes into account a wide choice of different routing possibilities for market development by combining several route segments into nonstop flights as warranted by the volume of passenger demand and the economics of airline operations. The model is sensitive to practical limitations on load factors, aircraft capacity, and/or other constraints, such as the availability or price of fuel.

Once the routing of aircraft among the 23 major cities was developed, a second program was used to generate schedules of aircraft departures between network city pairs. Using empirically derived time of day demand preferences, a set of departure "windows" was established for each domestic market, forcing departures at preferred or peak times, but allowing broader variation in departure time during off-peak hours if necessary. Assigning departures within permissible "windows" to minimize the aircraft fleet size, the scheduling model produces an "Official Airline Guide" (OAG) type schedule for any planning period, using the fleet assignment model frequencies, time of day traffic demand preferences, and its own scheduling logic.

The sequential routing and scheduling process described above was used to produce a series of OAG type time of day traffic profiles for each of the 25 primary air carrier airports in the 23 large hubs through the year 2000.

For all the airports in the 23 hub network, different 25-year traffic histories were developed, one representing the average time of day traffic profile associated with each of the four scenarios noted earlier. Approximately equal numbers of passengers were carried on respective markets in each scenario. The unique provisions of each scenario, however, resulted in different traffic patterns for each airport and time period.

Overall airport system delays under the four scenarios were computed and compared, and differences were attributed to the features of each scenario. This was the fundamental step in the analysis. The impact of the UG3RD on airport congestion, for example, was contrasted with peak-time pricing and quotas by comparing total system delays accumulated under the scenario most closely resembling each of these alternatives. Findings and conclusions of the report were based upon these comparisons.

Several analytical models have been introduced in this section, including a fleet assignment model, a scheduling model, and airport delay model. Each of these will be fully described in the following chapter. While a careful review of these models is recommended, the discussion which follows, as explained earlier, is presented primarily for the reader seeking a better technical understanding of the analysis. Other readers may wish to skim over Chapter 4 and continue with the following chapter, the Approach.

4.0 Description of Modeling

The process of predicting delays throughout a network of airports can be divided into three distinct steps: (1) the aircraft routing exercise, (2) the scheduling exercise, and (3) delay calculations. This chapter reviews each of these steps in detail.

4.1 Aircraft Routing

Aircraft routing is accomplished with a fleet assignment model, FA-4, which assigns aircraft over the network of cities in the manner of the U.S. domestic airline industry, that is, in such a way as to maximize profits for the airlines. In so doing, it takes into account a wide choice of different routings, the possibility for load building by combining several markets into multicity flights, and the opportunities for stimulating demand by improving service levels.

The FA-4 model was originally developed to assist in the fleet allocation decisions of commercial airlines, and, in fact, has been used in the scheduling process by several carriers. Because of its "real world" characteristic response, FA-4 has proven useful for exploring the behavior of air transportation companies in the face of widely varying regulatory and operational constraints. FA-4 addresses the following problem: Given passenger demand in designated markets, and given the costs of certain input factors such as fuel, vehicles, and labor, find the profit maximizing behavior of the firm. FA-4 solves the optimum airline strategy in terms of markets and capacity, making trade-offs with respect to cost, vehicle size, frequency, and routing.

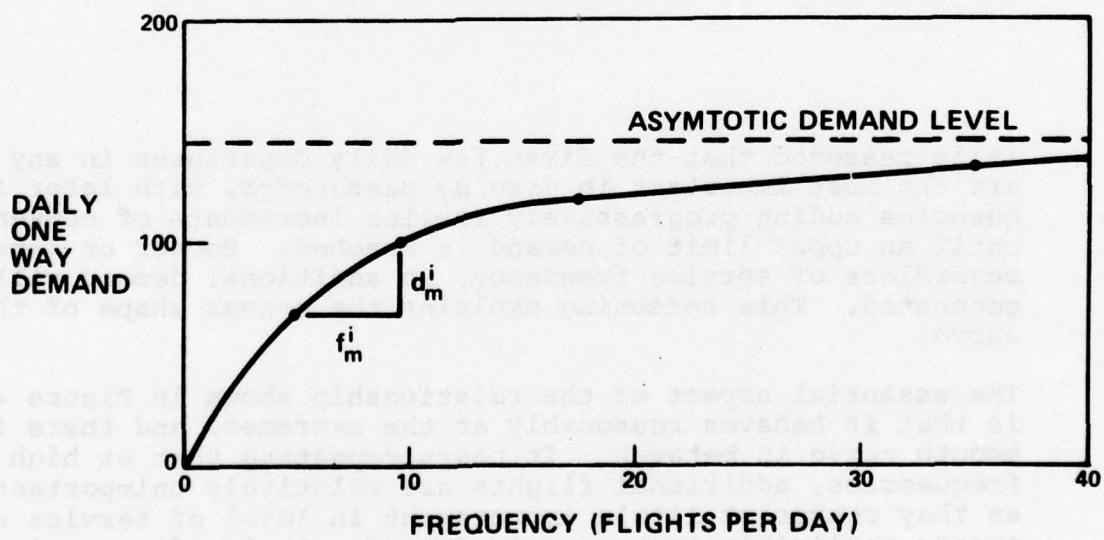
4.1.1 Demand Modeling

The FA-4 model is best introduced by discussing the process of air travel demand modeling. Each city pair market has a demand for travel which may be expressed as a curve relating passengers to the daily inter-city frequency of service. The shape and magnitude of this function determine the FA-4 solution of aircraft types, frequency, and routings. The discussion in this section explores the means by which the demand/frequency curve is generated.

Description of the Demand Curve

A typical traffic frequency curve is illustrated in Figure 4.1. This relationship assumes there is an upper limit on passenger demand in any city market; that is, there is an upper bound on demand, regardless of service frequency provided by the airlines. This is shown as an asymtotic demand level. At the other extreme, it is clear that a daily frequency of zero flights is equivalent to zero demand. No one flies when no aircraft are scheduled.

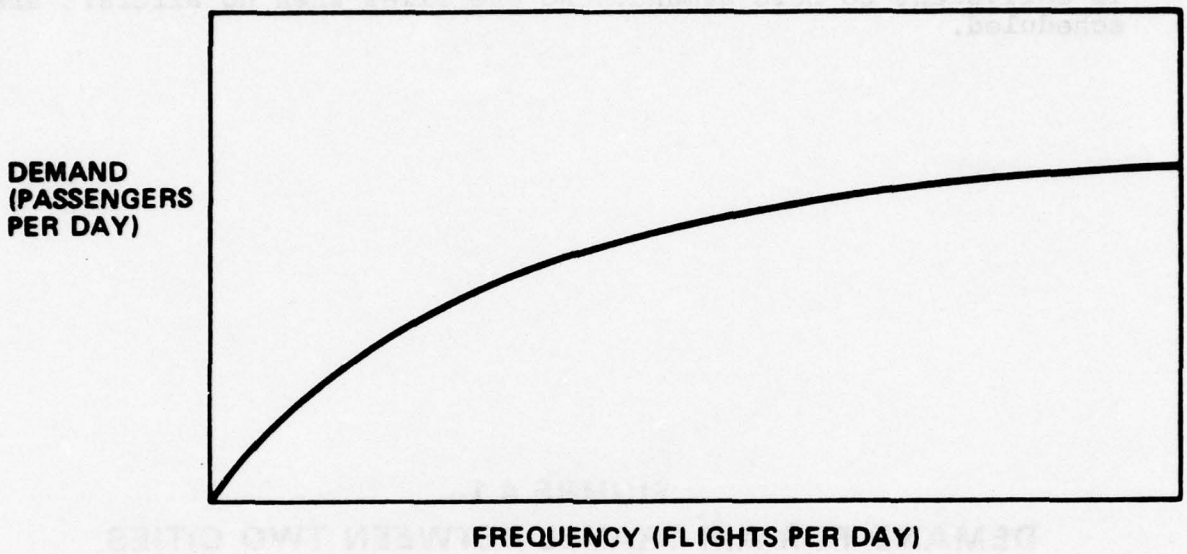
FIGURE 4.1
DEMAND FOR AIR TRAVEL BETWEEN TWO CITIES



The Treatment of Frequency

Passenger demand for air travel for this analysis can be represented by the typical demand curve illustrated in Figure 4.2. Here, demand = f (frequency).

FIGURE 4.2
A TYPICAL DEMAND CURVE



It is reasoned that the first few daily departures in any market are the most important in drawing passengers, with later frequencies adding progressively smaller increments of convenience until an upper limit of demand is reached. Sooner or later, regardless of service frequency, no additional demand will be generated. This reasoning explains the convex shape of the curve.

The essential aspect of the relationship shown in Figure 4.2 is that it behaves reasonably at the extremes, and there is a smooth curve in between. It bears repeating that at high frequencies, additional flights are relatively unimportant as they represent little improvement in level of service and create negligible increases in demand. At low frequencies, however, additional flights are very important as they generate more than a proportional increase in passengers.

The Impact of Flight Distance on Demand

Range or distance also has bearing on the demand frequency relationship. This can be expressed mathematically by the following equation:

(4.1) $\text{DEMAND} = K\ (t_o + W_o/\text{frequency})^{\alpha}$

K is a constant of proportionality

t_o is fixed-travel time, and includes the sum of block time, boarding time, access, and egress time.

W_o is a constant representing 1/2 the period of service provided.

W_o/frequency represents the average headway between service flights.

α is a constant value representing the elasticity of demand.

Equation 4.1 shows demand as function of total travel time, the sum of fixed travel time, t_o, and an additional shcedule delay, W_o/frequency. Schedule delay is defined as the inconvenience of waiting for the next departure. It is equal to half the average headway, or W_o/frequency. As frequencies increase, inconvenience waiting for a departure is minimized.

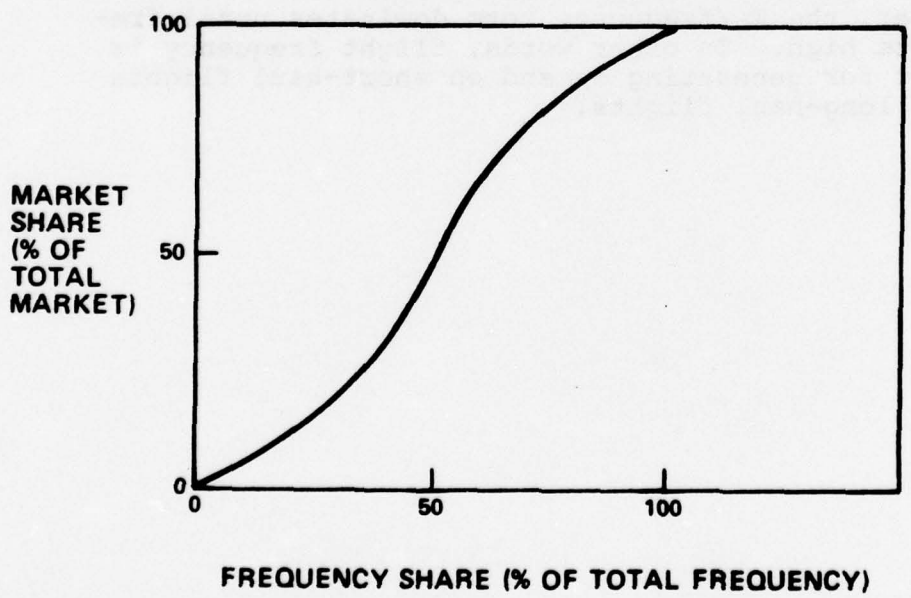
At long flight distances, t_o is a relatively large number, and the frequency term is comparatively small. At shorter ranges, however, the W_o/frequency term dominates until frequency is quite high. In other words, flight frequency is more important for generating demand on short-haul flights than it is on long-haul flights.

Competition

When two or more airlines compete over the same route, the effective frequency of service used to generate a passenger demand curve may differ from a simple count of the number of flights. In the generation of demand curves, frequency is defined as the number of departure options available to passengers in a given market. If airlines compete by scheduling nearly simultaneous departures, the number of departure options available to passengers is less than the sum of daily departure. In most cases, however, carriers share a market by scheduling alternating flights, in which case the frequency is equal to the number of total departures.

In competitive markets, passenger demand must be shared by two or more air carriers. Both practice and theory suggest that the market split follows the "S" shaped dependence on frequency share displayed in Figure 4.3. That is, a carrier's market share is less than proportional to his share of flight frequencies until he accounts for at least 50 percent of total flights. As his flights increase beyond that point, market share becomes more than proportional to his frequency share.

FIGURE 4.3
MARKET SHARE VS. FREQUENCY SHARE



Calibration from Existing Conditions

The demand model discussed in this chapter is expressed by the equation:

$$(4.2) \quad \text{DEMAND} = K\ (t_o + W_o/\text{frequency})^{\alpha}$$

This equation results in the geometrical shape displayed by the curve in Figure 4.2. Of the variables in this equation, only the existing frequency and number of passengers carried are generally known. The fixed time t_o is a characteristic of the aircraft and city pair. The term W_o is the length of the travel day, and is halved so that W_o/frequency is the scheduled delay. The elasticity is determined empirically from regression analysis of existing markets. The two known parameters, frequency and passengers carried provide the one point necessary for calibrating the demand curve. The demand model formulation fixes the shape of the curve, and the existing data point determines its size.

Treatment of Multiple Stops

The demand frequency relationship developed assumes that the expected level of service in FA-4 and the actual service used to calibrate the demand model are the same. If nonstop jet service was used in calibration, then nonstop jet service is the dimension of the frequency axis measure. However, FA-4 permits multistop routings and also allows the use of slower, or less appealing aircraft. What is needed is a conversion factor between different levels of service.

The market model permits this conversion to be made. In summarizing total frequencies, multistop flights were given a value of less than one.

Data Sources

Three pieces of data are needed to generate the single data point for each demand curve for a single airline:

1. Competition either as a frequency share or as a market share.

2. Existing total passenger travel on all airlines.

3. Existing single airline daily frequency, number of stops, and aircraft type.

Frequency share competition is available from examining the city pair in the OAG. Market share data is available from CAB Origin-Destination Surveys of airline passenger traffic. Total (or airline) passenger traffic is also available from the CAB references. Existing (or total) frequency is available from the OAG. Finally, fares are listed in the OAG, and distances in CAB Traffic statistics.

These data sources are used as inputs to a program which generates demand curve data points suitable for input to FA-4.

4.1.2 Mathematical Formulation

FA-4 is a linear program. Thus, the rules of the market place and of practicality are expressed as a series of constraints that airlines must obey. The solution procedure of FA-4 may be thought of as trying out every imaginable combination of aircraft, routes, and frequencies. Revenues and costs associated with each combination are added up, and that combination with the greatest excess of income over cost is selected as best.

The rules the solution must obey are the following:

1. The total cost of a system of airplane flights is the sum of the direct operating costs for each aircraft-route employed and the indirect operating costs proportional to passengers and passenger miles. Landing fees are included. However, administrative overheads do not affect the solution or routing decision. Overhead is taken out of the profits, if any.

2. The total income of the system is the sum of all the passengers carried times the fares paid.

3. No passenger is carried unless there are sufficient seats for him on each link of his flight. A maximum load factor establishes effective average aircraft capacities.

4. No more passengers are carried than the demand indicates. The demand, as discussed in Section 4.1.1, is limited by the level of service. Upper bound on the passengers is the upper bound on gross revenues in each market.

5. Finally, there may be a maximum number of departures allowed at any specific airport, due either to a physical or operational constraint.

Output from the aircraft routing exercise is a set of aircraft routes that are flown and the frequencies at which they are flown. The solution represents a predicted average over the year, and is, therefore, noninteger. That is, a route can be flown 4.7 or 11.3 times a day, for example. For planning purposes, all outputs can be rounded to integer values.

TABLE 4.1

DEFINITION OF TERMS AND VARIABLES USED IN THE MATHEMATICAL FORMULATION OF FA-4

π	Total airline profit
F_{rv}	Frequency of service on route r by aircraft v
$COST_{rv}$	Cost of service F_{rv}
D_m	Total passenger traffic in city pair market m
$FARE_m$	Fare for passengers in market m
f^i_m	Subsegment i of total frequency of service in market m
d^i_m	Slope of demand curve segment corresponding to f^i_m
K	Demand curve calibration constant
t_o	Travel time in a market
Freq	Total frequency of service in a market
W_{rm}	Weighting factor for frequency on route r with respect to frequency of service in market m
D_{mr}	Subcomponent of passenger traffic in market m. This part of traffic uses route r.
S_v	Seating capacity (with correction for load factor = 53 percent) for vehicle v
DEP_c	Total permissible departures from airport c
IOC^m_r	Indirect operating costs for passengers in market m by route r
P^m_r	Passengers in markets m by routes r
DOC^v_r	Direct operating costs for aircraft v on route r

The driving function for FA-4 solutions is profit maximization. Profit is defined here as excess of revenues over expenses, as shown in expression (4.3).

$$(4.3) \qquad \pi = \sum_m D_m \cdot FARE_m - \sum_r \sum_v F_{rv} \cdot COST_{rv}$$

A description of the terms used above is presented in Table 4.1. The equation says that profit, π, is airline revenues less costs. Revenues are the demand in each market D_m times the fare in that market $FARE_m$. The fare is reduced by indirect operating costs associated with ticket sales, boarding, cabin service, and baggage handling. The costs are a sum of the frequencies with which each vehicle flies each route, F_{rv}, times the cost for that vehicle to fly that route. $COST_{rv}$ is composed of total block hour direct operating costs for a given vehicle on a given route plus indirect operating costs associated with landing and gate operations plus landing fees.

Another way to visualize total costs, $COST_T$, is shown in equation (4.4).

$$(4.4) \qquad COST_T = \sum_m \sum_r P_r^m \cdot (IOC_r^m) + \sum_v \sum_r F_{rv} \cdot (DOC_r^v)$$

That is, total cost in the sum of indirect operating costs for passengers in markets m by routes r, (IOC_r^m), with direct operating costs for aircraft v on route r, (DOC_r^v).

The FA-4 model is sensitive to the rise in passenger demand triggered by an increase in service in a market, equation 4.5.

$$(4.5) \qquad D_m = \sum_i f_m^i \cdot d_m^i$$

This equation states that the demand in market m, D_m, is a factor of f_m^i, a bounded component of the demand frequency curve for market m (shown in Figure 4.0), and d_m^i, the slope of the corresponding segment of the demand curve. This curve, as noted previously, is calibrated from historical demand and frequency combinations.

Equation (4.6) establishes the shape of the demand frequency curve.

$$(4.6) \quad D_m = K(t_o + 6/\text{frequency})^{-1.3}$$

Here, K is the calibration constant and t_o is the sum of the flight time, access, boarding, and egress time. The term 6/frequency is the schedule inconvenience and is expressed as the average wait time.

Two definitional equations are necessary to complete the mathematical description of the model. The first merely establishes the total frequency in a market:

$$(4.7) \quad \sum_i f_m^i = \sum_r \sum_v F_{rv} \cdot W_{rm}$$

This equation says that the total frequencies for the purpose of calculating the demand equals the sum of the frequencies of all the vehicles over all the routes,

$$\sum_r \sum_v F_{rv}.$$

Each route frequency is weighted by a factor W_{rm}, for each market. If the route serves the market nonstop, W_{rm} is unity. If it serves the market with intermediate stops, the value of W_{rm} is less than one. The weighting function is complex and depends on the absence of historical nonstop service. If the route does not serve the market at all, W_{rm} is set equal to zero.

The second definitional equation expresses the total demand in each market, D_m, as a sum of passengers using one or the other market routes:

$$(4.8) \quad D_m = \sum_r D_{mr}$$

This identification is necessary so that the load factor constraint can be written. The load factor constraint sums the seats available on each link of each route r:

$$(4.9) \quad \sum_v F_{rv} \cdot S_v \geq D_{mr}$$

The capacity of each vehicle S_v times the frequency of that vehicle on the route F_{rv} must exceed the sum of the demands using that link.

Lastly, the activity at each airport is summed by summing the route vehicle frequencies which use the airport. This sum may be subject to a limit DEP_c:

$$(4.10) \quad \sum_r \sum_v F_{rvc} \leq DEP_c$$

It is this airport activity provision which allows FA-4 to test the system impacts of quotas, peak-pricing, and/or other airport capacity constraints.

This completes the description of the mathematics of FA-4.

4.1.3 Data Requirements

FA-4 has a wide number of options for inputting data and greater or lesser degrees of internal preprocessing are available. The following information must be provided in the minimum case:

1. IOC's: cost per aircraft departure, aircraft miles, passenger boarding, and passenger miles.

2. Fare structure: a zero distance cost, plus a cost per intercity mile.

3. Generalized equivalent nonstop frequency values for one-stop and two-stop services.

4. Station data: each airport name, the maximum daily departures, if there is a limit, and the landing fees, if any.

5. For each aircraft type: zero distance block time, cruise speed, seating capacity, cost per hour, maximum daily utilization, number of aircraft available.

6. For each route: the cities on the routes in the order served and the aircraft forbidden on each route (aircraft costs and times can be computed if not input here).

7. For each city pair market: the intercity distance, the demand curve as a series of straight line segments input as break points and slopes, and the maximum load factor. (Specific equivalent frequency coefficients may be input. Fares will be computed if not input here.)

The 23 city network evaluated by FA-4 for this analysis was first run for the year 1975. Demand, fare, and cost data for the year 1974 were used for calibration. The only changes for runs simulating later years were the demands. The 1974 dollars were used for both costs and fares throughout.

Table 4.2 lists the aircraft costs for the two vehicles postulated in this analysis. It was possible to introduce intermediate vehicle sizes. However, FA-4 can artificially create middle size aircraft by mixing service with the two extremes. Service with one wide aircraft and two small aircraft was the equivalent of three services with a 153 seat aircraft. This approximation reduces the size of the problem without sacrificing accuracy.

TABLE 4.2

AIRCRAFT COSTS 1/

NAME	SMALL	WIDE
Seats	80	300
Load Factor Maximum	53%	53%
Cost Per Hour	$775	$2,214
Speed	510 mph	510 mph
Take-off and Climb Time	15 min.	15 min.
Landing Fee and IOC	$156	$328

1/ These costs are above 1974 reported costs because depreciation has been replaced by a dry lease cost, which includes a return on investment. Costs for the 80-seat vehicle exceed B-737 and DC-9 costs because these two aircraft are short range while the 23 city network operated long-range flights. Sources: CAB Aircraft Performance Data, 1974, and "Flight International," January 3, 1974.

Indirect operating costs were estimated from empirical data to be $0.025 per revenue passenger mile and $8.00 per passenger boarding. 1/ These figures represented long-run marginal costs, which include a certain amount of lower management and sales overheads as well as the direct handling costs. Fares were approximated by the formula $16.80 + $0.0692/mile. This was 5 percent over 1974 fares. 2/

1/ A Multi Regression Analysis of 10C's," Simpson, R., and Taneja, N., Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL-R-67-2.

2/ Derived from May 1, 1974 OAG.

4.2 Aircraft Scheduling

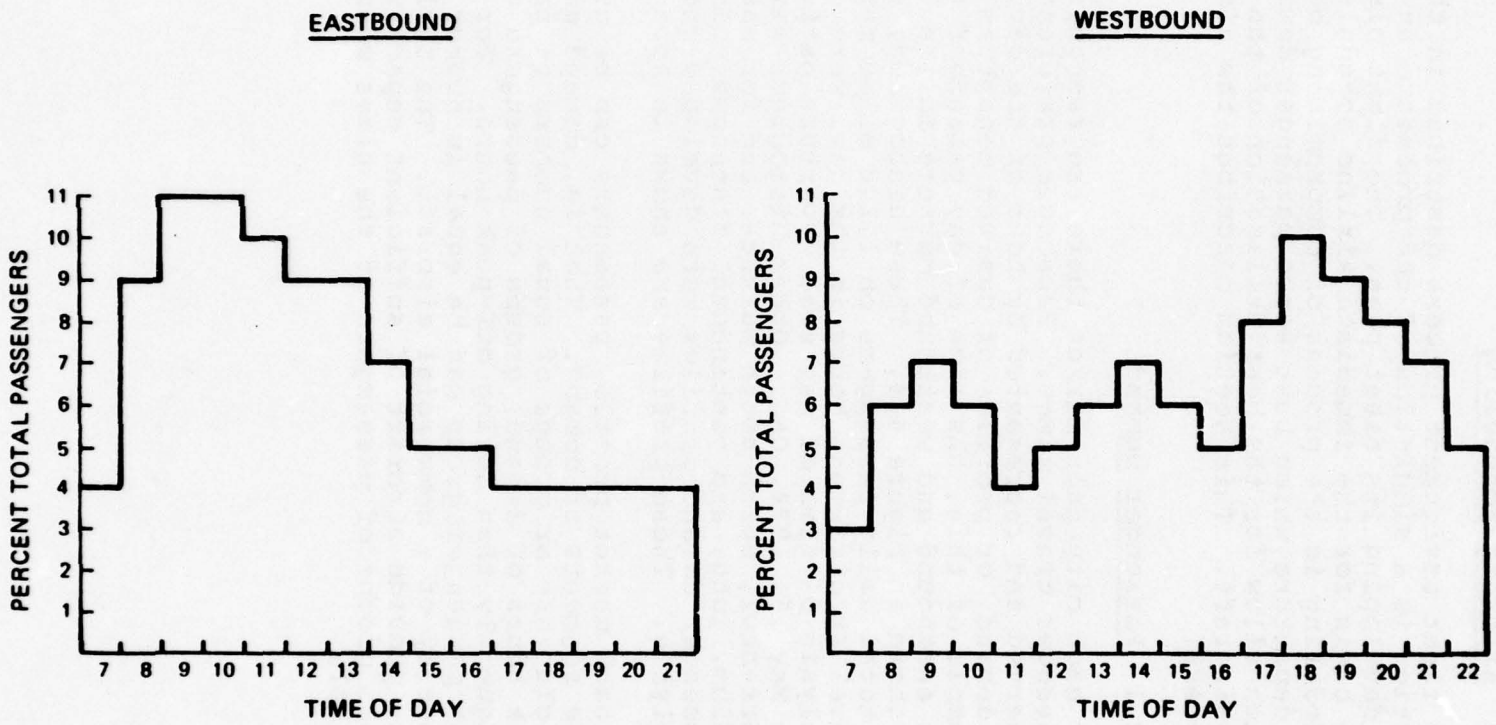
The fleet assignment process described in the preceeding section is a simulation of the procedure an airline follows in developing its fleet plan. The fleet plan then becomes the basis for the immediate airline schedule. Airline scheduling is the process of compromising between the times of departure which best serve passenger demand and the times which allow for the best utilization of the available fleet of aircraft. This section describes the aircraft scheduling process.

4.2.1 Passenger Demand

For each city-pair market there are recognized preferred passenger travel times. Passenger preferences can be observed and represented by hour of the day, distribution of demand, or profiles of desired departure times. As an example of this, the time of day passenger travel preference for eastbound and westbound markets in the 1,200 mile range is shown in Figure 4.4. These histograms, showing the percent of total daily passengers on 1,200 miles markets preferring to travel at different hours in the day, were developed from an analysis of time of day seat departure patterns scheduled in the May 15, 1974, OAG. Other histograms were developed for short-haul, north-south markets, and for east and westbound medium, long, and continental distances. In all, eight passenger demand profiles were developed and used for this analysis. These profiles are shown in Appendix C.

In each market profile, passengers can be grouped into equal size segments of demand. That is, demand can be represented by clusters or groups of equal numbers of passengers. At peak hours of demand, groups of passengers occur more frequently than during off-peak hours. For convenience, each passenger group can be equal in number to the seating capacity of a commercial aircraft. The airline schedule must provide aircraft of sufficient capacity to service these groups of passengers at the times when they prefer to travel.

FIGURE 4.4
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1200 MILE MARKETS



4.2.2 Fleet Scheduling

In the absence of any constraints on number of airplanes available, an airline scheduler would assign aircraft departures to the mid-point in time of each group of passengers, or segment of passenger demand. At peak hour of demand, the time between aircraft departures would be short, while in off-peak hours, time between departures would be longer.

The scheduler has a limited number of aircraft to use, however, and must service passenger demand with the aircraft available. To do this, he must move some flights away from the "ideal" schedule. For example, he must move some flights to an earlier departure, allowing them to connect at their destination with outbound flights. Or he may delay departures to connect with arriving aircraft.

The same scheduling strategy was used in this analysis. A scheduling model, SKEDGEN, began with a list of nonstop routes and associated frequencies of service. These were provided by the fleet assignment model, FA-4. Multistop routes were separated into their component nonstops and added to the nonstop listing. Then, an "ideal" schedule was developed to satisfy the demand. Aircraft were assigned departures at the mid-point in time of each group of passengers desiring air transportation. Then, in the manner of an airline scheduler, SKEDGEN adjusted departure times from ideal to minimize the number of aircraft required.

For the schedule adjustment operation, all the arrivals and departures at one airport were considered. Aircraft arrivals were advanced and/or departures delayed in order to allow single aircraft to serve on a connecting flight where two had been required for independent operations. This was continued so long as it did not interfere with aircraft schedules at another facility. Once the schedule at the first airport was adjusted, SKEDGEN considered the arrival/departure schedule at the next airport, and so on. The result of this fleet minimizing heuristic was an "Official Airline Guide" (OAG) type timetable of arrivals and departures for the entire system. As an example, the OAG generated for Chicago, O'Hare, year 2000, is shown in Figure 4.5.

Another key output provided by SKEDGEN, the one important for delay calculations, was the time of day history of aircraft activities at each airport. These histories, derived from the arrival and departure timetables, give the amount of peaking at an airport, a fundamental characteristic in the delay computations. The time of day aircraft movements forecast at Boston for the year 2000 are shown as an example in Figure 4.6.

FIGURE 4.5
FORECAST SCHEDULE OF FLIGHT ARRIVALS AT CHICAGO OHARE

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

FORECAST YEAR 2000
BASE CASE SCENARIO
SCHEDULED OAG

To CHICAGO, ILL. CST ORD (O'HARE)

Leave	Arrive
From ATLANTA, GA	**EST ALT**
6 40a	7 10a
7 45a	8 15a
8 30a	9 00a
10 10a	10 40a
10 50a	11 20a
11 50a	12 20x
13 00x	13 30x
14 20x	14 50x
15 25x	15 55x
16 20x	16 50x
17 10x	17 40x
17 55x	18 25x
18 35x	19 05x
19 25x	19 55x
20 20x	20 50x
22 00x	22 30x
BOSTON, MASS	**EST ALT**
6 50a	7 50a
8 00a	9 00a
8 55a	9 55a
10 05a	11 05a
11 15a	12 15x
12 30x	13 30x
13 25x	14 25x
14 25x	15 25x
15 35x	16 35x
16 30x	17 30x
17 15x	18 15x
17 50x	18 50x
18 30x	19 30x
19 15x	20 15x
20 00x	21 00x
21 00x	22 00x
CLEVELAND, OH	**EST CLE**
6 35a	6 35a
7 30a	7 30a
8 15a	8 15a
8 55a	8 55a
9 30a	9 30a
10 10a	10 10a
11 00a	11 00a
11 40a	11 40a
12 40x	12 40x
13 45x	13 45x
14 50p	14 50x
15 40x	15 40x
16 25x	16 25x
17 10x	17 10x
17 45x	17 45x
18 25x	18 25x
19 00x	19 00x
19 45x	19 45x
20 40x	20 40x
22 05x	22 05x
DALLAS FT. WORTH, TEX	**CST DFW**
6 35a	8 30a
7 20a	9 15a
7 55a	9 50a
8 25a	10 20a
8 55a	10 50a
9 20a	11 15a
9 50a	11 45a
10 20a	12 15a
10 55a	12 50x
11 30a	13 25x
12 05x	14 00x
12 40x	14 35x
13 20x	15 15x
14 10x	16 05x
15 10x	17 05x
16 20x	18 15x
17 40x	19 35x
19 00x	20 55x
20 20x	22 15x
DENVER, COL	**MST DEN**
6 25a	9 30a
7 10a	10 15a
7 35a	10 40a
8 00a	11 05a
8 20a	11 25a
8 40a	11 45a
9 05a	12 10x
9 20a	12 25x
9 45a	12 50x
10 05a	13 10x
10 30a	13 35x
10 50a	13 55x
11 15a	14 20x
11 50a	14 55x
12 10x	15 15x
12 35x	15 40x
13 00x	16 05x
13 35x	16 40x
14 10x	17 15x
14 55x	18 00x
15 40x	18 55x
16 35x	19 40x
17 35x	20 40x
18 35x	21 40x
19 30x	22 35x
20 20x	23 25x
	CONT NEXT COLUMN

To CHICAGO, ILL. CST CHI

From DETROIT, MICH	**EST DET**
6 20a	6 10a
7 10a	7 00a
7 40a	7 30a
8 10a	8 00a
8 35a	8 25a
9 05a	8 55a
9 30a	9 20a
9 55a	9 45a
10 30a	10 20a
11 00a	10 50x
11 30a	11 20a
12 05x	11 55a
12 45x	12 35x
13 35x	13 25x
14 20x	14 10x
15 00x	14 50x
15 35x	15 25x
16 05x	15 55x
16 35x	16 25x
17 30x	17 20x
17 55x	17 45x
18 25x	18 15x
18 50x	18 40x
19 15x	19 05x
19 45x	19 35x
20 25x	20 15x
21 10x	21 00x
22 20x	22 10x
HOUSTON, TEX	**CST HOU**
6 40a	8 50a
7 30a	9 40a
8 05a	10 15a
8 35a	10 45a
9 10a	11 20a
9 40a	11 50a
10 15a	12 25x
11 00a	13 10x
11 35a	13 45x
12 20x	14 30x
12 50x	15 00x
13 35x	15 45x
14 35x	16 45x
15 50x	18 00x
17 15x	19 25x
18 45x	20 55x
20 10x	22 20x
KANSAS CITY, MO	**CST MKI**
6 40a	7 45a
7 45a	8 50a
8 30a	9 35a
9 15a	10 20a
10 00a	11 05a
10 50a	11 55a
12 05x	13 10x
13 00x	14 05x
14 20x	15 25x
15 25x	16 30x
16 20x	17 25x
17 10x	18 15x
17 55x	19 00x
18 35x	19 40x
19 25x	20 30x
20 20x	21 25x
22 00x	23 05x
LAS VEGAS, NEV	**PST LAS**
6 20a	11 30a
7 00a	12 10x
7 35a	12 45x
8 05a	13 15x
8 35a	13 45x
9 05a	14 15x
9 40a	14 50x
10 10a	15 20x
10 45a	15 55x
11 20a	16 30x
12 00x	17 10x
12 30x	17 40x
13 10x	18 20x
13 55x	19 05x
14 45x	19 55x
16 00x	21 10x
LOS ANGELES, CAL	**PST LAX**
6 10a	11 50a
6 30a	12 50x
7 00a	12 40a
7 15a	12 55x
7 30a	13 10x
7 45a	13 25x
8 00	13 40x
8 15a	13 55x
8 30a	14 10x
8 45a	14 25x
9 00a	14 40x
9 15a	14 55x
9 30a	15 10x
9 45a	15 25x
10 05a	15 45x
10 20a	16 00x
10 40a	16 20x
10 55a	16 35x
11 10a	16 50x
11 30a	17 10x
11 45a	17 25x
12 05x	17 45x
12 25x	18 05x
12 40x	18 20x
	CONT NEXT COLUMN

To CHICAGO, ILL. CST CHI

From LOS ANGELES, CAL -CONT	**PST LAX**
13 00x	18 40x
13 20x	19 00x
13 45x	19 25x
14 05x	19 45x
14 30x	20 10x
15 00x	20 40x
15 35x	21 15x
16 25x	22 05x
MIAMI, FLA	**EST MIA**
6 50a	8 30a
8 00a	9 40a
8 55a	10 35a
9 55a	11 35a
11 20a	13 00x
12 35x	14 15x
13 30x	15 10x
14 25x	16 05x
15 35x	17 15x
16 30x	18 10x
17 15x	18 55x
17 50x	19 30x
18 30x	20 10x
19 15x	20 55x
20 00x	21 40x
21 00x	22 40x
MINNEAPOLIS, MINN	**CST MSP**
6 30a	7 30a
7 15a	8 15a
7 55a	8 55a
8 25a	9 25a
8 55a	9 55a
9 25a	10 25a
9 55a	10 55a
10 30a	11 30a
11 08a	12 05x
11 50a	12 50x
12 30x	13 30x
13 30x	14 30x
14 20x	15 20x
15 05x	16 05x
15 45x	16 45x
16 20x	17 20x
16 55x	18 55x
17 25x	18 25x
17 55x	18 55x
18 25x	19 25x
18 55x	19 55x
19 30x	20 30x
20 10x	21 10x
21 00x	22 00x
22 15x	23 15x
NEW ORLEANS, LA	**CST MSY**
7 15a	9 15a
8 45a	10 45a
10 00a	12 00x
11 30a	13 30x
13 25x	15 25x
15 40x	17 40x
19 10x	21 10x
NEW YORK, N. Y.	**EST NYC**
6 10a	6 35a
6 40a	7 05a
7 05a	7 30a
7 20a	7 45a
7 30a	7 55a
7 45a	8 10a
8 00a	8 25a
8 15a	8 40a
8 25a	8 50a
8 40a	9 05a
8 50a	9 15a
9 05a	9 30a
9 20a	9 45a
9 35a	10 00a
9 50a	10 15a
10 10a	10 35a
10 30a	10 55a
10 55a	11 20a
11 10a	11 35a
11 30a	11 55a
11 45a	12 10x
12 00x	12 25x
12 15x	12 40x
12 30x	12 55x
12 45x	13 10x
13 00x	13 25x
13 15x	13 40x
13 25x	13 50x
13 40x	14 05x
13 50x	14 15x
14 05x	14 30x
14 20x	14 45x
14 35x	15 00x
14 50x	15 15x
15 05x	15 30x
15 25x	15 50x
15 40x	16 05x
15 55x	16 20x
16 05x	16 30x
16 20x	16 45x
16 30x	16 55x
16 40x	17 05x
16 50x	17 15x
17 00x	17 25x
17 10x	17 35x
	CONT NEXT COLUMN

To CHICAGO, ILL. CST CHI

From NEW YORK, N. Y.-CONT.	**EST NYC**
17 20x	17 45x
17 30x	17 55x
17 35x	18 00x
17 45x	18 10x
17 55x	18 20x
18 05x	18 30x
18 15x	18 40x
18 25x	18 50x
18 35x	19 00x
18 45x	19 10x
18 50x	19 15x
19 05x	19 30x
19 15x	19 40x
19 25x	19 50x
19 35x	20 00x
19 50x	20 15x
20 00x	20 25x
20 10x	20 35x
20 25x	20 50x
20 35x	21 00x
20 50x	21 15x
21 05x	21 30x
21 25x	21 50x
PHILADELPHIA, PA	**EST PHL**
6 40a	7 20a
7 30a	8 15a
8 20a	9 00a
9 05a	9 45a
9 50a	10 30a
10 55a	11 35a
11 55a	12 35x
12 45x	13 25x
13 25x	14 05x
14 10x	14 50x
14 55x	15 35x
15 50x	16 30x
16 30x	17 10x
17 05x	17 45x
17 30x	18 10x
18 00x	18 40x
18 35x	19 15x
19 05x	19 45x
19 40x	20 20x
20 20x	21 00x
21 05x	21 45x
PITTSBURG, PA	**EST PIT**
6 30a	6 35a
7 25a	7 30a
8 05a	8 10a
8 40a	8 45a
9 15a	9 20a
9 50a	9 55a
10 30a	10 35a
11 05a	11 10a
11 45a	11 50a
12 45x	12 35x
13 50x	13 55x
14 45x	14 50x
15 35x	15 40x
16 15x	16 20x
16 55x	17 00x
17 30x	17 35x
18 05x	18 10x
18 40x	18 45x
19 25x	19 30x
19 55x	20 00x
20 50x	20 55x
22 10x	22 15x
SAN FRANCISCO, CAL	**PST SFO**
6 30a	12 20x
7 15a	13 05x
7 40a	13 30x
8 05a	13 55x
8 20a	14 10x
8 40a	14 30x
9 00a	14 50x
9 20a	15 10x
9 35a	15 25x
9 55a	15 45x
10 15a	16 05x
10 40a	16 30x
11 00a	16 50x
11 20a	17 10x
11 45a	17 35x
12 10x	18 00x
12 50x	18 40x
13 30x	19 20x
14 30x	20 20x
15 35x	21 25x
SEATTLE, WASH	**PST SEA**
6 25a	12 00x
7 15a	12 50x
7 45a	13 20x
8 20x	13 55x
8 55a	14 30x
9 35a	15 10x
10 10a	15 45x
10 50a	16 25x
11 30a	17 05x
12 10x	17 45x
12 50x	18 25x
13 35x	19 10x
14 35x	20 10x
15 55x	21 30x

FIGURE 4.6
TIME-OF-DAY AIRCRAFT MOVEMENTS AT BOSTON, YEAR 2000

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES 10	20	30	40	50
1					
2					
3					
4					
5					
6					
7	DDDDDDADD				
8	DDDDAAADDD	DADDDA			
9	DDDDAADAAD	DAADDADADD	DAADDDDA		
10	DDDAADADDD	AAADAADADD	DADAAAADDD	A	
11	DDAAADDDAD	DAAADDAAAD	DDDAADDDAD		
12	DAAAADDAAD	AAADADDAAA	ADDAADAADA	A	
13	DDADADADAD	AAADDAAAAD	DDAAADA		
14	DADAAADDAA	DADDDAAADA	AADDDDD		
15	DAAADDDDAD	DADDADDAAA	AAADDAADD		
16	AAADAADDAA	ADDDAAAAAA	DDDDA		
17	DDDAADAADD	AADDDDAADD	DAAADDAAAD	A	
18	DDAADDDDAA	ADDDAAAAAA	DDDADDADDA	DAA	
19	DDAADDDDAA	DDDAAAAAAD	DADAADDDAD	DADAAADDDA	
20	DAADDDDDAA	DDDDAAAAAD	DAADDDADDA	A	
21	AADDAADAAD	AADDAAAAAD	DDDA		
22	ADDDAADAAA	AAA			
23	DDAADAADAA	A			
24	AAAA				

28 OVERNIGHTING AIRCRAFT

A: ARRIVAL
D: DEPARTURE

4.3 Delay Calculations

The estimation of average and total airside delays at major airports is usually based either on queuing theory or on computer supported simulation. Alternatively, an extensive data collection program on delays at the airport of interest can be initiated. The work described here uses a simple and practical tool, A Handbook of Airport Delays, from which airport delays can be estimated using the knowledge of a few basic variables associated with any given airport. 3/

The basic quantity with which the handbook deals is that of average total daily delays (TDDEL's), i.e., the total delays experienced in the course of a typical day by aircraft attempting to use the runways of an airport. The delays referred to here are solely those due to normal runway congestion and do not reflect problems that may be due, for instance, to exceptional weather conditions or to other causes. No distinction is made between delays suffered by landing aircraft which have to queue in the air and those suffered by departing aircraft on the ground.

4.3.1 The Handbook of Airport Delays

The Handbook of Airport Delays is a collection of data statistics for a set of demand profiles specifically chosen to represent observed current demand patterns at air carrier airports. These profiles are used by computing airport delays by matching the demand profile under observation with that profile it most closely resembles in the Handbook of Airport Delays.

Standard profiles in the handbook were developed from traffic patterns at the top 100 U.S. airports. 4/ Two basic descriptions of demand characterize the profiles developed.

1. The number of daily peak periods. This identifies the general shape of the demand profile.

3/ A Handbook for the Estimation of Airside Delays at Major Airports, Amedeo Odoni and Peeter Kivestu, NASA Contractor Report NASA CR-2644, June 1976.

4/ Profiles of Scheduled Air Carrier Airport Operations - Top 100 U.S. Airports, Department of Transportation, Federal Aviation Administration, November 1973, and August 1974.

2. The "peak-hour operations as a percent of total daily operations." This is a rough indicator of the sharpness of the peaks and valleys in the demand profile. 5/

Ten profiles developed were representative of the traffic patterns observed at the top 100 airports. These profiles are identified below.

NP 7 - no peak 7%	OP 7 - one peak 7%	TP 7 - two peak 7%
NP 8 - no peak 8%	OP 8 - one peak 8%	TP 8 - two peak 8%
	OP 9 - one peak 9%	TP 9 - two peak 9%
	OP10 - one peak 10%	TP10 - two peak 10%

The graphs of TDDEL, for each of the ten profiles plotted against an average "hourly" capacity, are provided in the handbook with the computational techniques described in this section. These ten TDDEL graphs are the core of the handbook. The user selects one of the ten profiles most closely matching the observed airport profile. Knowledge of the airport capacity then allows straightforward graphical lookup from the appropriate TDDEL graph. For example, Figure 4.7 illustrates the "two peak; 8 percent" (TP8) standard traffic profile. For this profile, total daily delay values (TDDEL's) were developed using the delay programs discussed in Section 4.3.2. These are shown as a series of nomographs in Figure 4.8. Given an airport with a TP8 profile, 86 operations/hour capacity, and 92 operations in the peak hour, daily delay is approximately 5,400 minutes.

4.3.2. Delay Programs

The primary tool used for the computation of the TDDEL graphs was the DELAYS set of computer programs developed at the Flight Transportation Laboratory of MIT. A summary description of the theoretical development is given in the technical discussion.

Briefly, the programs are used as follows:

1. The input information consists of the "standard" hourly profiles of total demand (total of demanded landings and take-offs); the average hourly saturation (or "maximum throughput") capacity; and the number of runways assumed.

5/ For the generalizations made to fill out the shape of the remainder of the profile the reader is referred to the handbook.

FIGURE 4.7
AIRPORT TRAFFIC DISTRIBUTION

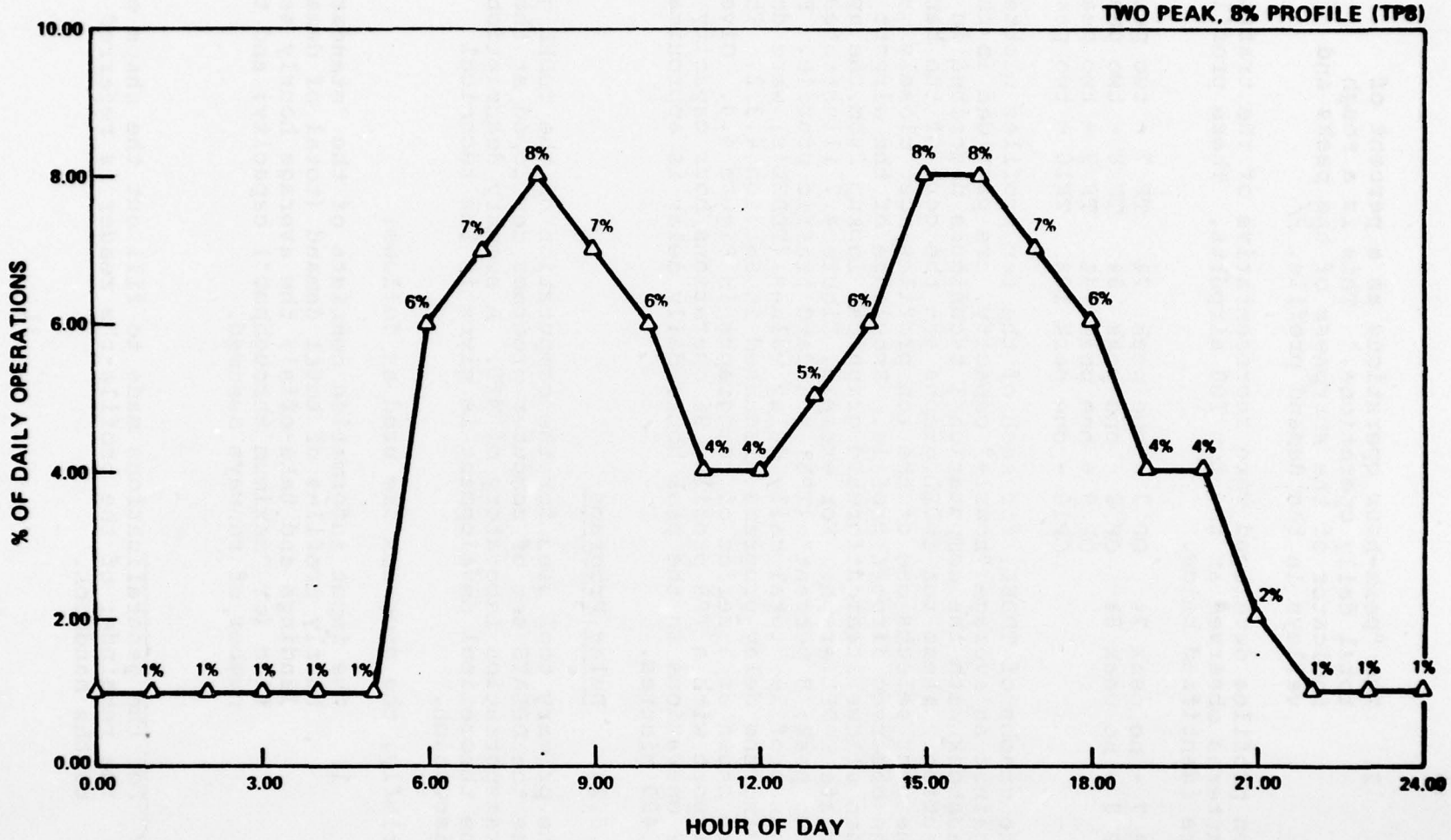
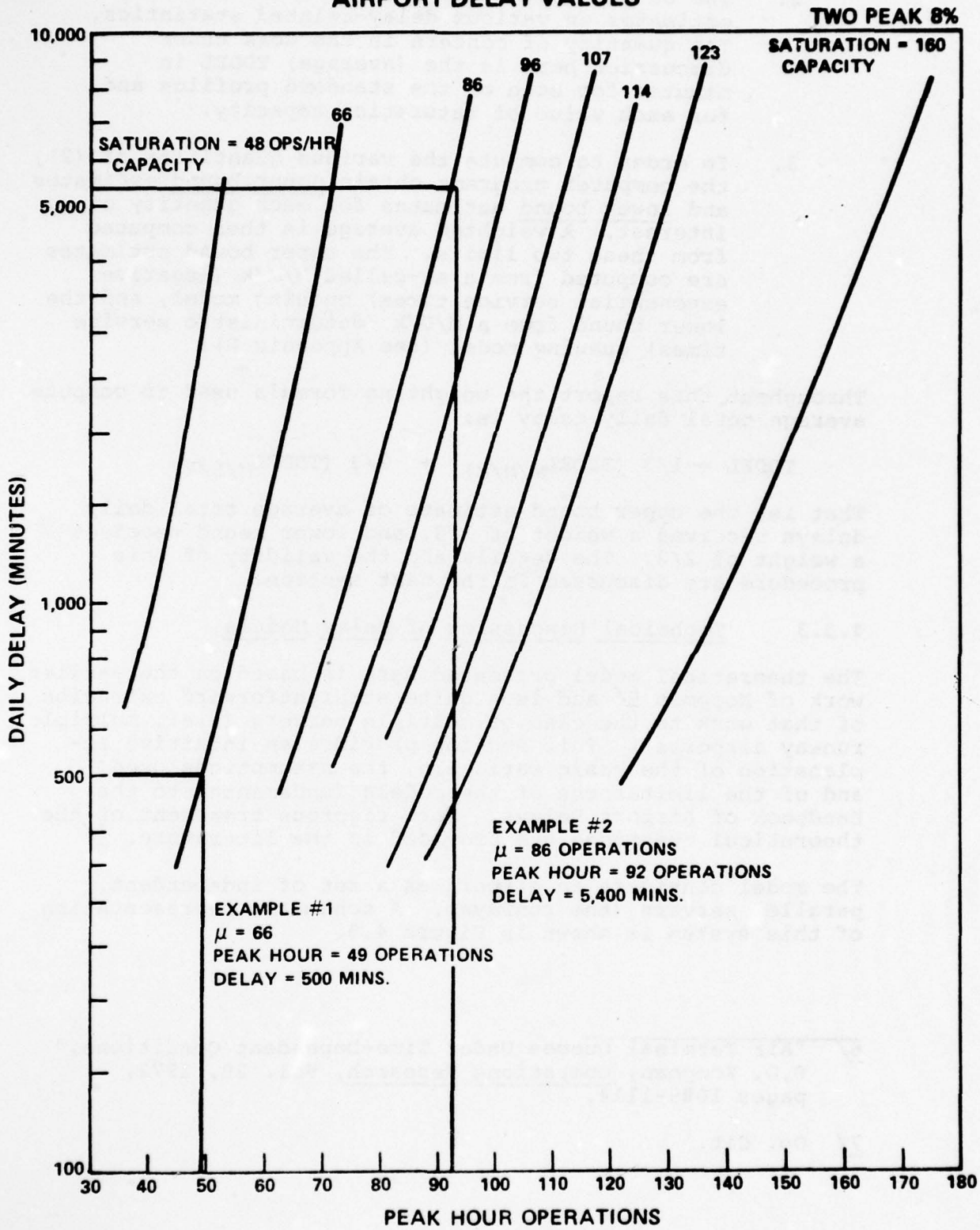


FIGURE 4.8
AIRPORT DELAY VALUES



2. The output of the computer programs provides estimates on various delay-related statistics. The quantity of concern in the work under discussion here is the (average) TDDEL in minutes for each of the standard profiles and for each value of saturation capacity.

3. In order to compute the various quantities of (2), the computer programs obtain upper bound estimates and lower bound estimates for each quantity of interest. A weighted average is then computed from these two limits. The upper bound estimates are computed from a so-called M/M/k (negative exponential service times) queuing model, and the lower bound from a M/D/k (deterministic service times) queuing model (see Appendix D).

Throughout this report the weighting formula used to compute average total daily delay is:

$$TDDEL = 1/3\ (TDDEL_{M/M/k}) + 2/3\ (TDDEL_{M/D/k})$$

That is, the upper bound estimate of average total daily delays receives a weight of 1/3, and lower bound receives a weight of 2/3. The details and the validity of this procedure are discussed in the next section.

4.3.3 Technical Discussion of Delay Models

The theoretical model presented here is based on the earlier work of Koopman 6/ and is a quite straightforward extension of that work to the case of multiple servers (i.e., multiple runway airports). This section provides an intuitive explanation of the basic rationale, the assumptions used, and of the limitations of the models fundamental to the Handbook of Airport Delays. More rigorous treatment of the theoretical questions are provided in the literature. 7/

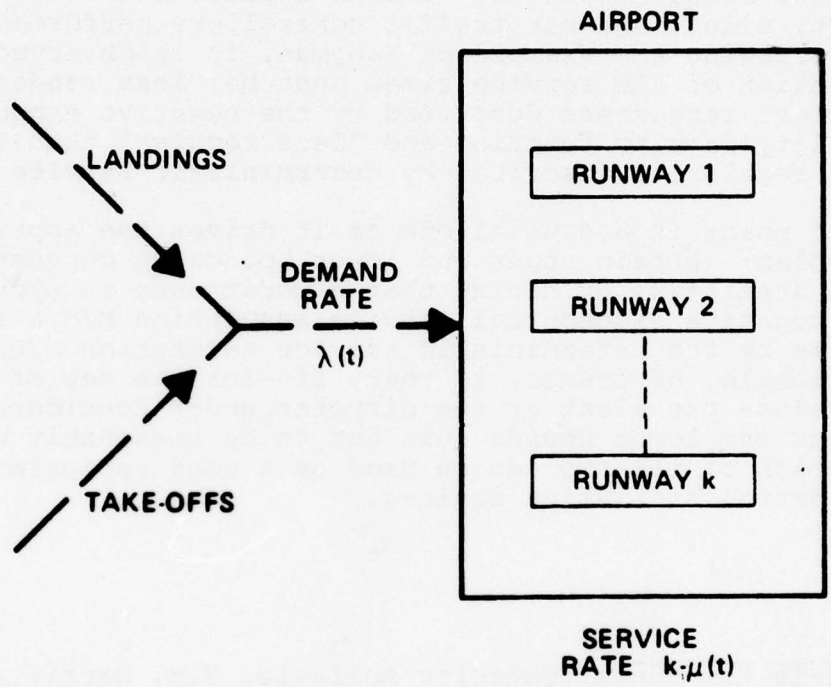
The model considers an airport as a set of independent, parallel servers (the runways). A schematic representation of this system is shown in Figure 4.9.

6/ "Air Terminal Queues Under Time-Dependent Conditions," B.O. Koopman, Operations Research, Vol. 20, 1972, pages 1089-1114.

7/ Op. Cit.

FIGURE 4.9

SCHEMATIC REPRESENTATION OF THE QUEUING MODEL



It is assumed that the total demand at the airport--that is, the sum of the demands for landing and for take-offs--is a Poisson process with a time-dependent average demand rate, given by $\lambda(t)$. The Poisson assumption for airport demand is consistent with actual observations at several major airports and has been used extensively in the literature. 8/

By contrast, the form of the probability law describing the duration of a service at the runways is still a matter for speculation. 9/ The duration of the period, during which a runway is busy with an aircraft, depends on such diverse factors as type of operation being conducted, weather, aircraft mix, runway configuration in use, runway surface conditions, location of runway exits, air traffic control equipment, requirements for minimum separations between aircraft, pilot, and air traffic controllers performance, etc. Following the example of Koopman, it is observed that the duration of the service times must be "less random" than the perfect randomness described by the negative exponential probability density function and "less regular" than the perfect regularity described by deterministic service times.

The last point is a crucial one as it drives the approach to the problem: obtain upper and lower bounds on congestion-related statistics by noting that a worst case is provided by the negative exponential service assumption M/M/k and a best case by the deterministic service assumption M/D/k. The rationale, of course, is that, if--for the set of parameter values prevalent at the airports under consideration--the upper and lower bounds turn out to be reasonably weighted combination of the two can be used as a good approximation of the actual statistics desired.

8/ Models for Runway Capacity Analysis, R.M. Harris, Report MITRE, the MITRE Corporation, McLean, Virginia, December 1972. Also, Analysis of a Capacity Concept for Runway and Final Approach Path Airspace, U.S. National Bureau of Standards, Report No. NBS-10111, AD-698-521, November 1969.

9/ An Analytic Investigation of Air Traffic in the Vicinity of Terminal Areas, A.R. Odoni, Operations Research Center, Massachusetts Institute of Technology, Cambridge, 1969.

Here, then, is the strategy to be followed: Given an airport with k independent runways, each of which has a time-dependent average service rate $\lambda(t)$, solve iteratively, and for the desired period of time, two systems of equations, one describing an M/M/k queuing system and the other an M/D/k queuing system. 10/ The actual values of interest will then be bounded from above and below by the values obtained from these two queuing models. This whole approach is dictated by the fact that the differential equations describing an M/G/k (arbitrary) queuing system--a more realistic model for the case of interest--are unwieldy even for the purpose of obtaining numerical solutions.

Assumptions in the Model

To complete the description of queuing models which are fundamental to the airport delay calculations, the assumptions which were made are identified here. The most important of these, from a practical viewpoint, is the assumption of the existence of a single queue of aircraft awaiting use of the runways on a strictly first-come, first-served basis. Thus, there is no distinction between landing and departing aircraft. While, in practice, the average service times (and the probability distributions) for landings and take-offs are different, a single weighted average service time for both kinds of operations is used.

Another assumption is that all active runways (or, all the parallel servers in Figure 4.9) operate independently and are identical. In practice, runways often cannot be operated independently, since operations at one may affect those on another, due to airport geometry. Again, from the practical viewpoint, this assumption is not too restrictive since dependencies among the servers, if they exist, can be accounted for by adjusting the service rates accordingly. As an example, consider an airport with a single runway which can handle, say, 50 aircraft movements per hour, i.e., the average service time in 72 seconds. Suppose, now, that operations are begun at a second runway which intersects the first one. Then, the overall airport capacity might increase to, say, 80 operations per hour, and not to 100 as it would if the two runways were independent. To account for this in our model, we would then assume the existence of a single independent server, with an average service time of 45 seconds, for an overall airport capacity of 80 movements per hour.

10/ The M/M/k and M/D/k queuing systems are described in Appendix D.

Obviously, the number of state-transition equations, describing the queuing models and being iteratively solved by the computer, must be finite. Since the number of such equations is equal to the number of states in the queuing model, it must be assumed that the queuing system of Figure 4.8 can accommodate up to a maximum of m aircraft (including the ones in service at the k servers). The variable m can be selected large enough to make it highly unlikely that the number of aircraft in the terminal area, at any given instant, will be equal to m.

Finally, it is assumed that successive service times are statistically independent. This is substantially true in reality, as little attempt is made under today's air traffic control regime to sequence operations in anything but a first-come, first-served way. Successive service times are, therefore, randomly mixed according to the mix of aircraft with little or no interdependence among them.

5.0 Analytical Approach

Peak-pricing and quotas were evaluated in this analysis on the basis of potential reductions offered in congestion and air carrier delays at the 25 largest air carrier airports. Delays were computed assuming a system of: (1) conventional airport improvements, (2) peak pricing and quotas, (3) UG3RD improvements, and (4) peak-pricing and UG3RD. Different scenarios were developed to represent these situations.

Airline passenger enplanements through the year 2000 were forecast, and the airport network model, introduced in Chapter 4, was developed to translate these anticipated enplanements into projected air carrier aircraft operations. Delays at each airport were computed on the basis of air carrier traffic projections.

Total airport system delays were assessed for each scenario. The alternatives under review, peak-pricing, quotas, and the UG3RD, were evaluated by comparing system delays in each scenario.

The work program undertaken to accomplish this analysis can be divided into four major elements:

1. Development of Scenarios
2. Passenger Demand Forecast
3. Air Traffic Forecast
4. Delay Computation

Each of these elements is discussed in the following sections.

5.1 Development of Scenarios

In order to test the impact of quotas and peak-load pricing on airport system delays, a series of four operational scenarios or situations was developed. Each scenario defined a unique air transportation system in terms of airport capacities and air traffic demand. Two of the scenarios employed peak-pricing and quotas, two did not. Each scenario, however, provided for equivalent numbers of air passengers carried.

The four scenarios included:

- Base Case Scenario

  The airport system enhanced only by conventional capacity improvements

- Peak Pricing and Quota Scenario

  Pricing and administrative options provided in addition to conventional airport improvements

- UG3RD Scenario

  Airport capacities were enhanced with UG3RD hardware features 1/

- Peak-Pricing and UG3RD Scenario

  Peak-pricing schedules supplementing UG3RD hardware improvements

In the Base Case scenario, airport capacities were generally defined by the present system. Time phased capacity enhancements provided by conventional hardware improvements (parallel runways, extended runways, extra taxiways, etc.) over the period 1975-2000 were identified by the MITRE Corporation. 2/ Typically, a schedule of capacities, or throughput rates, were identified for each airport in the network at 5-year intervals through the planning period.

1/ UG3RD components are described in The National Aviation System: Challenges of the Decade Ahead, 1977 - 1986, DOT, FAA, 1976.

2/ Airport capacities and improvement schedules under each scenario are defined in the MITRE Corporation memorandum W 43-127.7, July 31, 1975.

Discussions of the subject of airport capacity often assume a single value. Actually, airports may have numerous capacities, each operating at different times.

In the Base Case scenario, airports were identified by up to four capacities. At most airports, Visual Flight Rules (VFR) capacity exceeded the capacity under Instrument Flight Rules (IFR) conditions. This is explained by the fact that aircraft operating in visual conditions are able to maintain closer separation, which means that more aircraft can use the facilities in a given period of time. Similarly, at most airports there is a difference in capacity when aircraft are using the normal duty runways and the capacity which prevails during cross-wind conditions when an alternative runway is required. Airports are generally configured to provide maximum capacity during normal wind conditions.

The case of Boston's Logan Airport can be used as an example. The four current Base Case capacities at Logan are shown below:

Runway Strategy	IFR	VFR
Normal	53.9	111.3
Cross-Winds	50.3	89.8

The relative percentage of times in each condition are as follows:

Runway Strategy	IFR	VFR	All Conditions
Normal	8%	63%	71%
Cross-Winds	8%	21%	29%
All Conditions	16%	84%	100%

For each time period, each of the capacity measures shown above and the percentage of time in that capacity condition is figured in the analysis.

5.2 Passenger Demand Forecast

The scenarios described in Section 5.1 were compared by examining the capacity of each to accommodate air passenger forecasts through the year 2000. These passenger forecasts, developed by the FAA's Aviation Forecast Branch, are shown in Table 5.1. For a quantitative discussion of the forecasting methodology, the reader is referred to Appendix A in Aviation Forecasts--Fiscal Years 1975 to 1986.

Projected air carrier passenger enplanements are derived from econometric forecasting models. The fundamental assumptions underlying these models are that various measures of aviation activity are related to the level of economic activity and that the various activity measures are dependent on one another in a predictable way. The model for air carrier enplanements is based upon economic data from the years 1964 through 1973. The model relates level of air carrier activity to the total consumption of services, the number of civilians employed, investment expenditure in the aircraft industry, the price of air travel relative to that of other modes of transportation, and purchases of automobiles. Tests of the model show that an increase in automobile purchases or air fares can be expected to result in a decrease in revenue passenger enplanements, whereas increasing the portion of the population that uses air carrier services, improving the level of service, or increasing the consumption of services can be expected to increase enplanements.

TABLE 5.1

UNITED STATES CERTIFICATED ROUTE AIR CARRIER DOMESTIC SCHEDULED PASSENGER TRAFFIC 1/

Fiscal Year	Revenue Passenger Enplanements (Millions)
1975	200.7
1976	215.3
1977	231.0
1978	247.8
1979	262.3
1980	276.1
1981	288.5
1982	301.7
1983	315.0
1984	328.9
1985	346.0
1986	355.0
1987	369.1
1988	383.9
1989	399.1
1990	415.1
1991	431.8
1992	448.4
1993	466.3
1994	483.7
1995	502.1
1996	520.7
1997	540.7
1998	561.5
1999	588.2
2000	604.5

1/ UG3RD Baseline and Implementation Scenario. National Baseline Forecast. FAA Policy Development Division, November 20, 1975.

It was assumed for the Base Case scenario that aircraft were serviced, or allowed runway access on a first come, first served basis. With no priority system, therefore, the probability that any one type of aircraft was first in the queue for runway use was equal to the relative percentage of use by that type (air carrier, air taxi, military, etc.). At each airport, it was assumed that military, commuter, air taxi, other general aviation, and nonscheduled operations accounted for 20 percent of the runway demand throughout the day. 3/ This was accomplished in the analysis by assigning 20 percent of available airport capacity to these users.

Airport capacities in the Peak-Pricing and Quota Scenario were the same as described in the Base Case throughout the planning period. However, airports were assumed to price non-air carrier traffic (defined here as military, air taxi, commuter, other general aviation, and non-scheduled operators) out of the system whenever delays were encountered. At most airports, this still allowed a variable amount of unscheduled use during VFR or off-peak conditions.

In the Peak-Pricing and Quota Scenario, airport which experienced significant annual average delays imposed peak-pricing schedules to smooth air carrier demands. A 6-minute rule was used to identify significant annual airport delay. At 6 minutes of annual delay, an airport experiences noticeable delays in all operating conditions. During VFR operations, which typically occur approximately 85 percent of the time, delays amount to slightly less than 4 minutes on the average. In IFR conditions, average delay can approach 20 minutes per aircraft movement, or 40 minutes per flight, and airlines may begin to cancel operations. For this analysis, peak-pricing schedules were implemented by smoothing passenger demands on flights which arrive and depart congested airports. This had the effect of smoothing aircraft demand. Finally, absolute daily quotas were imposed whenever peak-time pricing was inadequate to limit average annual delay to 6 minutes or less.

3/ This assumption was made in order to facilitate the analysis. Latest figures show that general aviation, air taxi (commuter), and military aircraft traffic ranges from 13 percent of all operations (in Atlanta) to 65 percent (in Las Vegas). This traffic averages 20 percent of total at the top seven commercial airports, and for this reason, the 20 percent estimate was chosen. The reader is referred to FAA Air Traffic Activity, CY-1974, DOT, FAA, March 1974, page 34. Also, The National Aviation System: Challenges of the Decade Ahead, 1977-1986, DOT, FAA, 1976, page 5.

Airport capacities in the UG3RD Scenario, the third of four scenarios developed, were enhanced by time-phased implementation of conventional improvements, as well as the technical features of the UG3RD. One of these features, the Wake Vortex Avoidance System (WVAS), is programmed to detect wake vortex dissipation, and will allow terminal aircraft operation at lower separation standards and higher frequencies. This adds a third dimension to the airport capacity matrix, as shown below for Logan Airport.

LOGAN AIRPORT CAPACITY, YEAR 2000

Wake Turbulence / No Wake Turbulence	IFR	VFR
	66.8	129.6
Normal Winds	82.1	135.9
	58.3	97.0
Cross Winds	58.9	107.0

The percentage of time in each condition is as follows:

Wake Turbulence / No Wake Turbulence	IFR	VFR
	2%	40%
Normal Winds	6%	13%
	2%	8%
Cross Winds	6%	5%

In other words, each of the airports in this scenario can be described by up to eight capacities, each one operating at different times. The capacity estimates for all airports evaluated are presented in Appendix E.

The fourth, and final, case is the Peak-Pricing, UG3RD Scenario, which incorporates UG3RD improvements, as well as the peak-time pricing strategy already described. Because of the increase in airport capacities provided by the UG3RD, and the smoothed demand under a peak-pricing schedule, no quotas were required in this scenario.

Numerous assumptions were made regarding the general economic climate for the planning period of this report. These assumptions and the forecast economic variables for the air carrier enplanement models relate to those variables used by the Council of Economic Advisors. The factors discussed here include forecasts of several of these key economic indicators. 4/

First, the Nation's gross national product (GNP) in constant 1958 dollars is forecast to increase from $748 billion (est) in 1975 to $1,169 billion in 1985, an average growth rate of 4.0 percent per year. GNP is estimated to reach $1,870 billion by the year 2000 at an average growth rate of 3.2 percent per year. See Figure 5.1. Population is expected to grow at the rate of 1 percent per year.

Total personal consumption expenditures are expected to increase from $533 billion (est) in constant 1958 dollars in 1975 to $770 billion in 1985, and $1,201 billion in 2000. See Figure 5.2.

It is anticipated that the inflation rate will decrease from 10.1 percent (est) in 1975 to an average of 7.1 percent per year until 1980, then 5.5 percent per year from 1980 to 1985, and then 5 percent per year from 1985 until 2000.

Finally, real personal disposale income (RDI) is expected to grow at an annual average rate of 4.5 percent for the period 1975 through 1986, the rate of growth (about 5.2 percent) increasing for the 1987 through 1990 period and slowing (about 3.4 percent) for 1991 through 2000. The assumed increase in RDI's rate of growth for 1987 through 1990 is based upon the expectation of continued strong expansionary fiscal policies and large catch-up wage gains after a prolonged drop in real wages. The relatively slower rate of growth over the 1990 through 2000 period is attributed to expected moderation in wage demands, constraints placed upon Government expansionary policy due to increased tax burden, rekindled inflationary pressures stemming partly from earlier wage gains, and partly from energy shortages and expected capacity bottlenecks impacting on employment.

4/ Provided by UG3RD Baseline and Implementation Scenario, FAA Policy Development Division, November 20, 1975.

FIGURE 5.1
PROJECTED GROSS NATIONAL PRODUCT
(1958 DOLLARS)

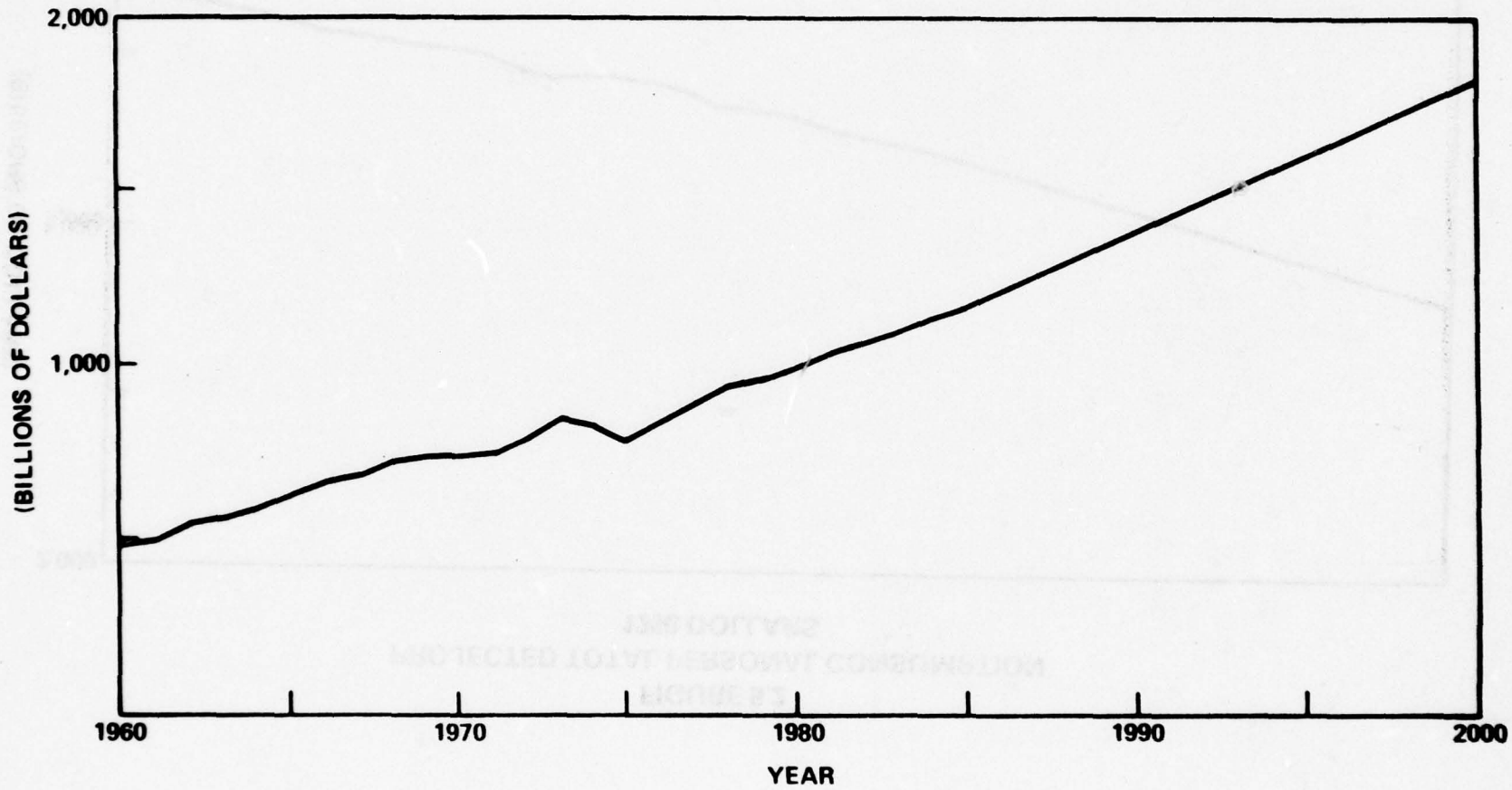
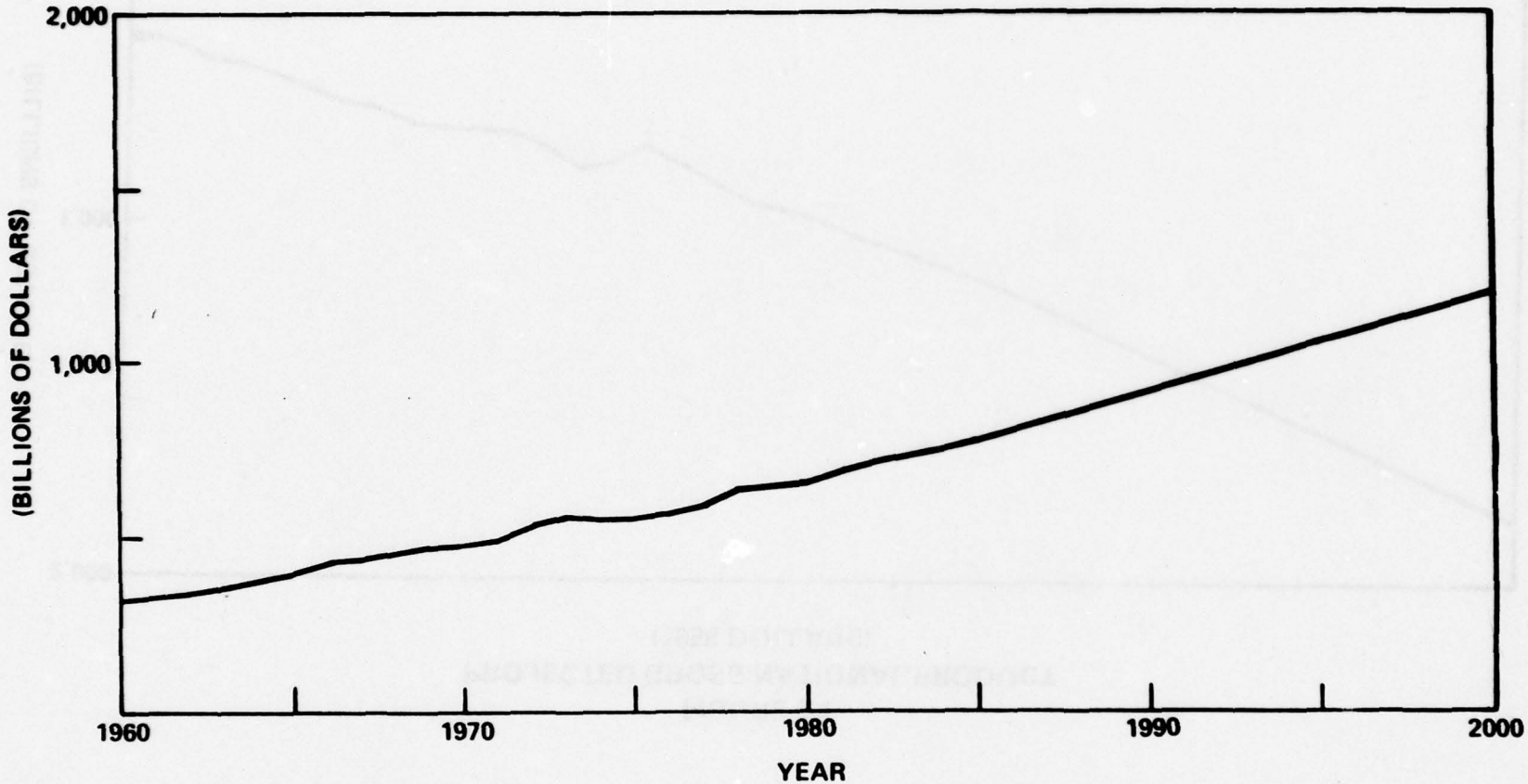


FIGURE 5.2
PROJECTED TOTAL PERSONAL CONSUMPTION
1958 DOLLARS



Passenger enplanement forecasts, once developed, were used to derive projected passenger demands on each city pair market. Using 1974 as a base, the growth rate of passenger enplanements was computed at 5 year intervals through the year 2000. This growth schedule, roughly averaging 4.5 percent annual increase, is shown in Table 5.2.

To establish the level of activity in 1974, current (1974) passenger demand on each city pair market was compiled from Civil Aeronautics Board (CAB) publications. 5/ This passenger demand is presented in Appendix F. Passenger forecasts were then derived by multiplying the number of passengers on each 1974 market (Appendix F) by the growth factors shown in Table 5.2. This provided an estimate of the passenger demand on each city pair market for each forecast year through the planning period.

5.3. Air Traffic Projections

Aircraft traffic projections were derived from passenger enplanement forecasts using the airport network model described in Chapter 4.0. Delays at each airport, then, were computed from these air traffic projections.

Several features of the network model that should be mentioned here. First, while there are 25 airports in the model, a consolidation of airport in the New York Hub, JFK, LaGuardia, and Newark, reduced the number of network cities to 23. Although New York was treated as a single travel destination for modeling purposes, air traffic was manually divided among the three airports so that delay levels were equalized. In Washington, D.C., National Airport remained the destination of all Washington traffic now serving the airport. No new nonstop authority was assumed. Therefore, direct flights from DEN, DFW, HNL, IAH, LAS, LAX, MCI, SEA, and SFO did not serve National Airport.

Nonstop and multistop markets or flights were developed to link the 23 network cities and provide alternative routes for meeting passenger demands. With such a large network, a formidable number of nonstop and multistop city pair flights could be hypothesized. A strategy was developed to limit the alternatives to the most likely city pair combinations.

5/ This was compiled from the May 15, 1974, OAG and from Tables 8 and 10 of the 1974 annual Civil Aeronautics Board Origin and Destination Tables.

TABLE 5.2

SCHEDULE OF PASSENGER ENPLANEMENT GROWTH

1974 Base

Year	Growth Factor
1975	1.00
1980	1.30
1985	1.74
1990	2.07
1995	2.51
2000	3.02

First, all markets currently receiving nonstop service continued to receive service throughout the planning period. This amounted to 243 direct city pair routings. Those markets served exclusively nonstop were generally not offered other possibilities, i.e., one stop or two stop service.

Multistop flights were added next. All one and two stop markets now being serviced were offered several alternatives in both routing and number of stops. All flights through Chicago, for example, were provided alternative routings. When complete, the model included 445 nonstop, one stop, and two stop route options. These are listed in Appendix G.

With all possible city pair routings fully defined, the airport network model was exercised to derive air carrier flight activity from the passenger enplanement forecasts presented in Section 5.2. Activity was described in terms of hourly operations throughout the average day at each of the 25 airports in the network. Forecasts were developed for 1985, 1990, 1995, and the year 2000. A summarization of this daily airport activity is shown in Table 5.3.

It is noted that the 1995 and year 2000 forecasts show two estimates of average daily airport activity levels. Numbers in parentheses represent projected operations for the peak pricing and quota scenario, which are different from the other three scenarios. Not only are the total number of operations different in this scenario, but the profiles of flight activity are different as well. Appendix H compares the projected year 2000 activity profiles for each airport in the network under Base Case and peak pricing/quota assumptions. The profiles show a noticeable difference in the peaking characteristics of airport traffic in each scenario.

5.4 Delay Computation

As noted in the previous sections, implementation of the scenarios described in Chapter 4 resulted in airport traffic levels which were unique in terms of numbers of overall operations, and/or the pattern of traffic activity throughout the day, and/or the capacity available for air carrier operations at each airport. Consequently, each scenario established a different level of airport system delay. The computation of anticipated delay was accomplished with the model described in Section 4.3. The procedure adopted in this analysis for applying the model and computing airport delays is explained in the following paragraphs.

TABLE 5.3
FORECAST AIR CARRIER DAILY OPERATIONS 1/

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

AIRPORT	1985	1990	1995 2/	2000 2/
ORD	1842	1875	2030 (1875)	2215 (1875)
BOS	815	900	1000 (1000)	1150 (1150)
SFO	843	915	995 (965)	1095 (1098)
STL	576	708	830 (825)	909 (904)
DEN	738	933	970 (975)	1065 (1035)
LAX	1133	1253	1502 (1502)	1725 (1715)
SEA	573	580	610 (600)	695 (710)
PHL	481	519	565 (565)	750 (685)
CLE	452	470	530 (555)	585 (610)
NYC 3/	1665	1745	1885 (1885)	2200 (2160)
ATL	1100	1200	1220 (1240)	1315 (1310)
MSY	438	475	500 (505)	570 (560)
MSP	518	550	625 (625)	665 (665)
DTW	596	650	690 (665)	785 (665)
MCI	503	555	665 (680)	810 (785)
DFW	952	962	1010 (1014)	1190 (1195)
PIT	682	700	755 (750)	786 (759)
MIA	705	750	960 (960)	1075 (1070)
HOU	515	600	681 (647)	723 (694)
LAS	396	443	526 (491)	709 (557)
HLU 4/	470	530	643 (661)	800 (826)
TPA	559	581	633 (626)	674 (656)

1/ DERIVED FROM FAA PASSENGER ENPLANEMENT FORECASTS

2/ ACTIVITY LEVELS IN PARENTHESES INDICATE AIR CARRIER OPERATIONS FOR PEAK PRICING AND QUOTA SCENARIO (#2).

3/ INCLUDES JFK, LGA, EWK

4/ HONOLULU FORECASTS ARE INVALID–LOW CORRELATION WITH OBSERVED ACTIVITY LEVELS

First, the airport departure and arrivals activity profiles developed by the network model were examined (see Section 4.2). As explained earlier, these traffic profiles represented only the services provided among the 23 cities. To reflect the rest of the air carrier demand, the ratio of scheduled traffic among the 23 cities compared to all scheduled operations was computed for each airport. These ratios are listed in Appendix I. 6/ The ratios were then used to expand the predicted schedules to reflect total air carrier operations at each respective airport. The assumption was made that for any airport in the network markets to the top 23 cities would grow at the same rate as other commercial traffic, and, therefore, traffic expansion factors shown in Appendix I remained constant throughout the planning period of the analysis.

Next, each airport activity profile was categorized by number of traffic peaks, and the percentage of total daily traffic operating in the peak hour. This categorization allowed the computation of airport delays in the manner explained in Section 4.3.

Air carrier delays were computed for each of the two to eight hourly capacities applicable to each airport (see Section 5.1). Within each hourly capacity, cancellations were assumed to occur whenever the average daily delay per operation reached 20 minutes, equivalent to 40 minutes average delay per scheduled departure. Sufficient cancellations were enforced to maintain the 20 minute maximum, on the assumption that air carriers would not allow delays to exceed this limit.

Finally, aircraft delays and flight cancellation rates were weighted by the relative percentage of occurrence of each capacity condition, and aggregated by airport. The overall result was annual average delay and cancellation rates. These delays are listed by airport in Appendix J. Different annual air carrier delays are recorded for each of the four scenarios under evaluation.

6/ Derived from OAG, June 1, 1975, schedules.

The costs of air traffic delay to the airlines and airline passengers were computed at each airport in the network through the year 2000. The direct operating costs (DOC) of the airlines were derived for each aircraft type from 1975 CAB statistics. The assumption was made that passenger time was valued at $12.50 per hour. The results, by airport and scenario, are shown in Appendix K.

6.0 Results

The preceding chapters described the models applied, as well as the approach for the analysis of the impact of peak-pricing and quotas on airport system delay. This chapter presents the results of the analysis. Conclusions drawn from these findings are presented in the final chapter of the report.

6.1 Air Carrier Airport Delay

Airport delays resulting from each traffic distribution (i.e., scenario) were computed for 1975, 1985, and at 5-year intervals thereafter through the year 2000. These delays were aggregated over all airports in the 23 city network. Airport system totals are shown for each scenario in Figure 6.1. Delay tables for individual airports, as well as annual system totals throughout the planning period, are presented in Appendix J.

Figure 6.1 provides the means for evaluating the comparative advantages of airport policy alternatives. The impact of the UG3RD on airport delay, for example, may be contrasted with delays under a system of peak pricing and quotas by comparing the respective curves shown in the Figure.

The costs of air traffic delays anticipated in each of the four scenarios (see Appendix K) were aggregated for all airports in the network and discounted to 1975 dollar values. 1/ These anticipated delay costs are shown in Table 6.1. It is noted, for example, that a peak-load pricing schedule implemented in concert with UG3RD technological improvements could eliminate almost 80 percent of the cost of air traffic delays anticipated at the 25 largest airports through the year 2000.

Another measure of system capacity and/or service quality is the rate of flight cancellations at an airport. As explained earlier, under certain heavy traffic conditions flights were cancelled in order to avoid situations of unrealistically large delays. These cancellations may inconvenience air

1/ A 10 percent discount rate was used.

FIGURE 6.1
TOTAL ANNUAL AIR CARRIER DELAY 25 AIRPORT SYSTEM

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

SYSTEM DELAYS UNDER
ALTERNATIVE SCENARIOS

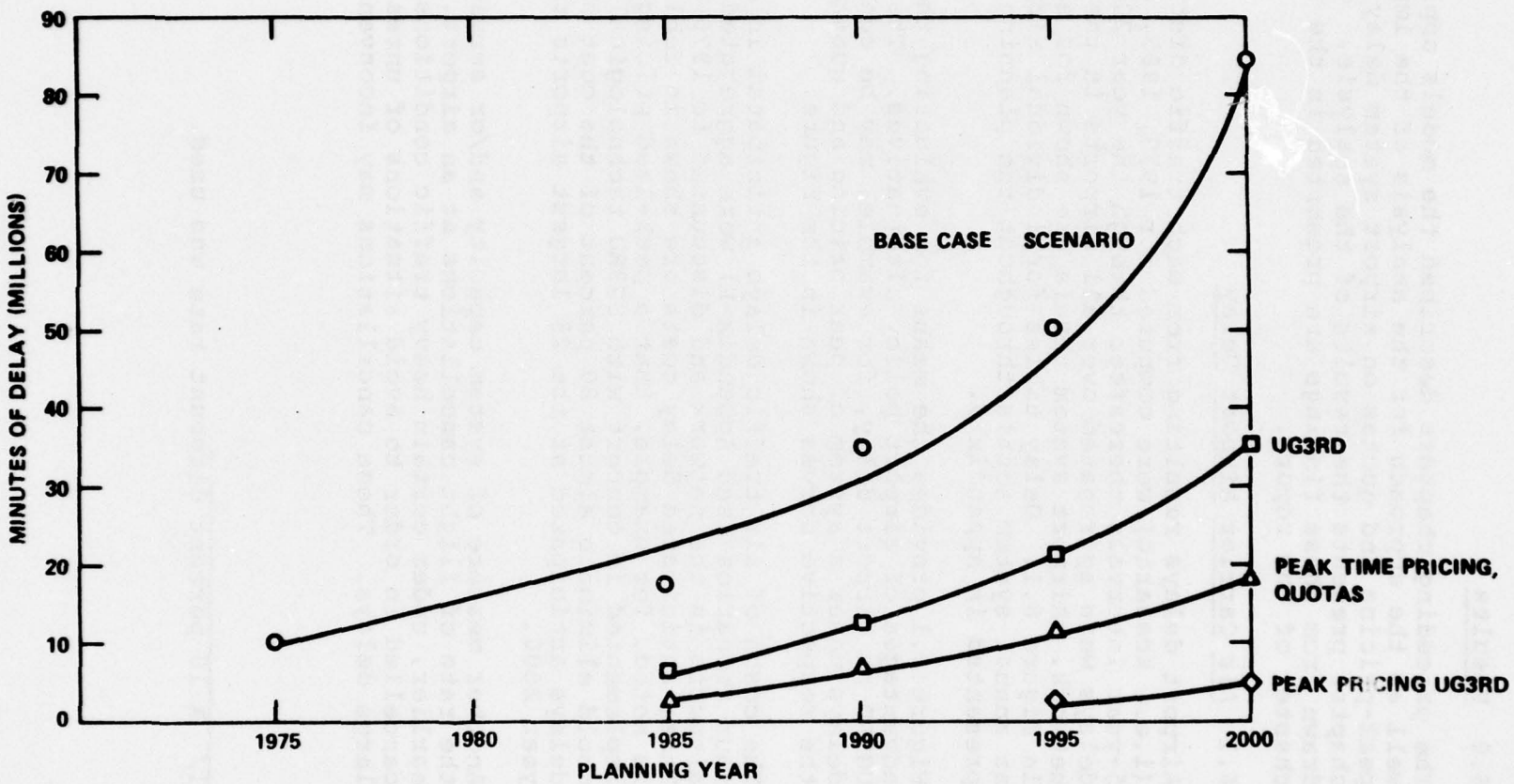


TABLE 6.1

DISCOUNTED COST OF AIR CARRIER DELAY IN THE 25 AIRPORT SYSTEM THROUGH THE YEAR 2000

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

SCENARIO	DELAY COSTS 1/ ($ MILLIONS)
BASE CASE	$7,107
PEAK PRICING & QUOTAS	2,489
UG3RD	3,540
PEAK PRICING & UG3RD	1,504

1/ Aircraft and Passenger Delay Discounted at 10% to 1975 Dollars

travellers and/or airline operators, and may be viewed as a disbenefit. 2/ Each scenario has its own unique traffic distribution and, consequently, its unique flight cancellation rate. The projected occurrence of flight cancellations under the UG3RD may be contrasted with those under peak-pricing and quotas by comparing projected cancellation rates shown in Figure 6.2.

6.2 Traffic Forecasts

Traffic forecasts derived by the airport network model described in this report are presented in Table 5.2. As noted, these forecasts are based upon the passenger enplanement forecasts shown in Table 5.1. Equivalent numbers of passengers were carried in each scenario developed for the analysis.

It is observed that the threefold growth in air passenger demand anticipated by the year 2000 results in a less than proportional increase in aircraft operations. At some of the busiest airports, for example, annual growth rates for passengers and aircraft operations are 4 percent and 1 percent, respectively. An explanation for this is that many of the larger markets are already receiving frequent service, and much of the predicted passenger growth is accommodated with larger aircraft instead of increased flight frequency. In addition, there is a tendency towards more point-to-point or direct service, eliminating some of the multistop routes. This report finds that a shift towards wide-body aircraft utilization and direct routing of flights results in less airport activity in future years than would be anticipated from simple assessments.

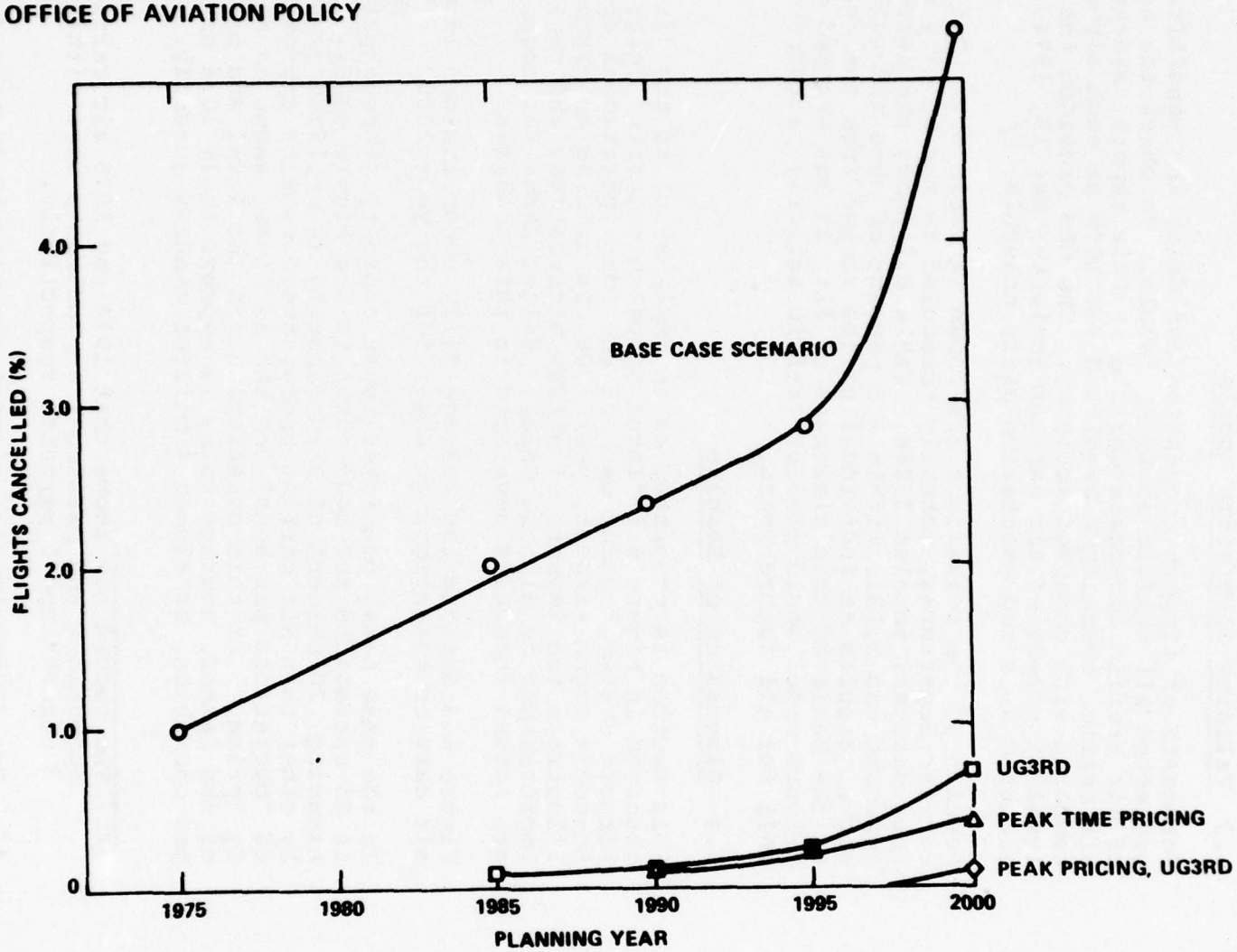
In addition to accelerating the shift towards larger aircraft and direct routing, the peak-pricing and quota strategy implemented in this analysis resulted in the rescheduling of some (less than 20 percent) air carrier traffic. Most commercial operations were unaffected. The non-air carrier operators, however, were essentially "priced" out of congested periods of operation at the primary air carrier airports. Most of the reduction in peak-hour operations, as a result of marginal cost pricing, came from the non-air carrier users.

2/ It is estimated that no more than 20 percent of all airline passengers in any forecast year were subjected to flight cancellations. In every case, seats were made available to these displaced travellers on an earlier or later departure. In the worst case, passengers were displaced a maximum of 2 hours from their desired departure times.

FIGURE 6.2

PROJECTED FLIGHT CANCELLATION RATES AT THE 25 MAJOR AIR CARRIER AIRPORTS

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY



6.3 Validity of Traffic Models

Forecasts of airport congestion and delay are sensitive to projected air traffic activity levels. To check the accuracy of air traffic forecasts derived in this report, average daily air carrier operations predicted for 1975 at each airport were compared with observed activity. The OAG provided the current level of scheduled air carrier activity; May 15, 1974, was selected as a representative daily schedule. 3/

Results of the comparison are shown in Table 6.2. Daily air carrier departures, actually scheduled to the 23 city network destinations, totaled 3,244. Table 6.2 shows the network model forecast was 3,082, within ± 5 percent of observed values. As shown, results at individual cities varied from the aggregate. On the basis of this closeness of fit, it was assumed the airport network model would predict traffic activity patterns reasonably well for all future years.

6.4 Discussion of Results

This section is presented as an explanation of the differences observed in Figure 6.1 "Total Annual Air Carrier Delay, 25 Airport System," under each of the four operational scenarios. Boston's Logan Airport, year 2000, is used as an example to illustrate the impacts of policy alternatives and capacity improvements on airport delay. Values shown for Logan Airport are actual forecasts developed in this analysis.

Figure 6.3 depicts the average daily unconstrained level of air carrier operations at Logan for the year 2000.

In the Base Case, predicted Logan capacity (throughput rate) is 85 operations per hour shown in the Figure as C_1. 4/ Assuming, 20 percent of this capacity is utilized or consumed by other than air carrier users, there remains approximately 68 "operations per hour" for the airlines, shown as capacity C_1 "prime." At this capacity, given the level and profile of the demand, average delay is approximately 10.6 minutes per operation, or almost 4 million minutes annually.

3/ The record now shows that 1974 and 1975 air carrier operations and passenger enplanements were within 3 percent and 1 percent, respectively.

4/ See discussions on airport capacity in Section 4.1. The concept of average capacity is used here for purposes of discussion only. In reality, there are up to eight different capacities for Logan Airport.

TABLE 6.2

FLEET ASSIGNMENT MODEL VALIDITY CHECK

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

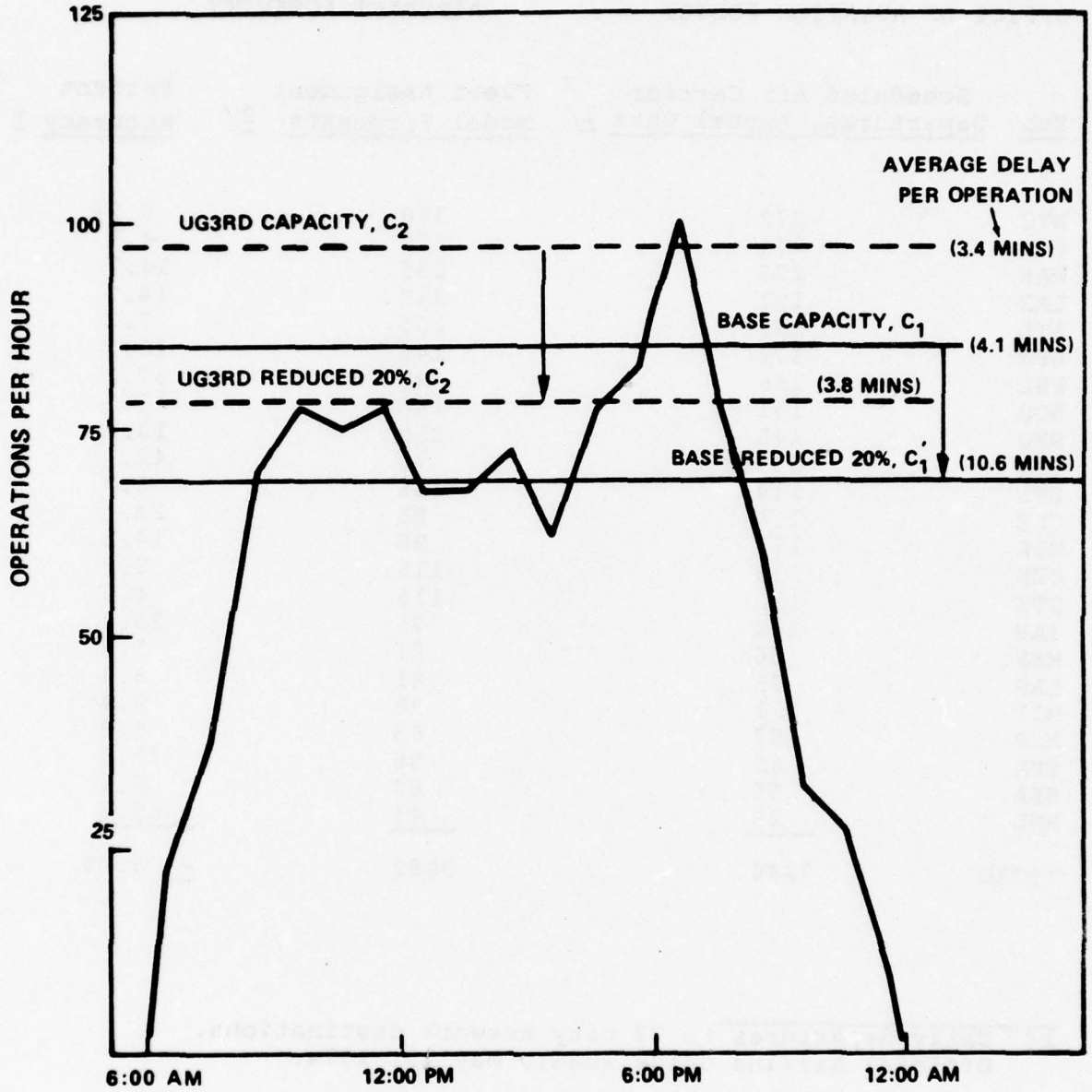
COMPARISON OF INTRA NETWORK TRAFFIC FORECASTS WITH ACTUAL AIRCRAFT ACTIVITY

Hub	Scheduled Air Carrier Departures, Actual Data 1/	Fleet Assignment Model Forecasts 2/	Percent Accuracy ±
NYC	373	370	0.2%
ORD	353	369	4.5
WAS	273	233	14.7
LAX	191	219	14.7
ATL	178	165	7.3
DFW	172	144	16.3
PHL	156	98	37.2
BOS	151	146	3.3
SFO	145	165	13.8
PIT	133	77	42.1
STL	119	111	6.7
CLE	116	88	24.1
MIA	115	98	14.8
DEN	113	116	2.7
DTW	110	115	4.5
IAH	101	75	25.4
MSP	86	81	5.8
LAS	75	81	8.0
MCI	71	78	9.9
MSP	67	63	6.0
TPA	65	86	32.3
SEA	55	60	9.1
HNL	26	44	69.2
TOTAL	3244	3082	± 5.0%

1/ Daily departures to 23 city network destinations. Official Airline Guide (OAG), May 15, 1974.

2/ Daily departures to 23 city network destinations.

FIGURE 6.3
FORECAST DAILY AIR CARRIER DEMAND, YEAR 2000 [1]
BOSTON, LOGAN AIRPORT



[1] AIR CARRIER OPERATIONS DERIVED FROM FAA PASSENGER ENPLANEMENT FORECASTS

If, however, all other users were priced out, or otherwise denied airport access during congested periods, air carriers would have the full capacity (C_1), or 85 operations per hour, at their disposal. Airline delay under these conditions would decrease to 6.1 million minutes a year, an average of 3.8 minutes per operation, and a savings of 2.3 million minutes of annual air carrier delay over the Base Case.

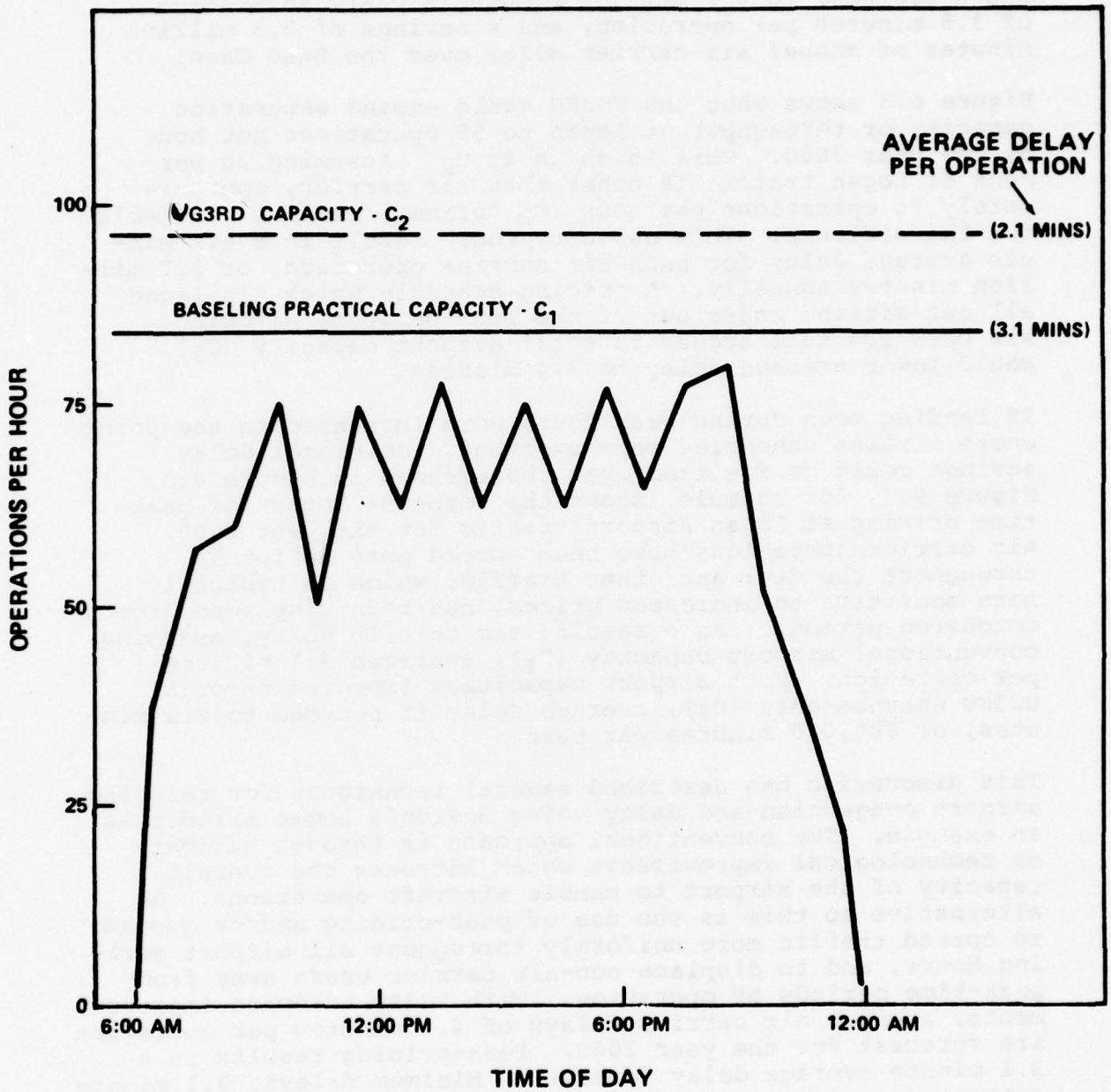
Figure 6.3 shows that the UG3RD would expand saturation capacity or throughput at Logan to 95 operations per hour by the year 2000. This is shown as C_2. Assuming 20 percent of Logan traffic is other than air carrier, approximately 76 operations per hour (C_2 "prime") remains available for the airlines. This capacity would result in a 4.1 minute average delay for each air carrier operation, or 1.7 million minutes annually. A pricing schedule which displaced all but airline users out of the peak periods, allowing air carriers full access to total airport capacity (C_2), would lower average delay to 3.4 minutes.

If landing fees during peak hours were increased to the point where airline schedules were smoothed, additional delay savings could be realized over those shown in Figure 6.3. Figure 6.4, for example, shows the forecast impact of peak-time pricing at Logan Airport traffic for the year 2000. Air carrier operations have been spread more uniformly throughout the day; and other traffic, which is typically more sensitive to increased prices, has been displaced from congested periods. As a result, air traffic delay, assuming conventional airport capacity (C_1), averages 3.1 minutes per operation. With airport capacities improved through UG3RD enhancements (C_2), average delay is reduced to 2.1 minutes, or 880,000 minutes per year.

This discussion has described several techniques for reducing airport congestion and delay using Boston's Logan Airport as an example. The conventional approach is through hardware or technological improvements which increase the overall capacity of the airport to handle aircraft operations. An alternative to this is the use of peak-pricing and/or quotas to spread traffic more uniformly throughout all airport working hours, and to displace non-air carrier users away from peak-time periods of operation. With UG3RD hardware improvements, average air carrier delays of 4.1 minutes per operation are forecast for the year 2000. Peak-pricing results in a 3.1 minute average delay forecast. Minimum delays, 2.1 minute average per operation, result from a combination of UG3RD technological enhancements and a peak-time pricing schedule.

FIGURE 6.4

FORECAST DAILY AIR CARRIER DEMAND, YEAR 2000 — BOSTON, LOGAN AIRPORT PEAK HOUR PRICING



Comparable results were observed at the remaining airports in the network. This is shown in the delay and cost of delay estimates presented in Appendices J and K. In each case, a schedule of peak-pricing and quotas reduced air carrier airport delays appreciably. Furthermore, this report found no evidence of adverse network or ripple effect induced by airport pricing or quota limitations. That is, at no time did the imposition of pricing or quota limitations at an airport resulted in increased traffic congestion at other facilities such that total system delay was not reduced.

The purpose of this analysis was to answer two basic questions about peak-time pricing and airport quotas. First, could they relieve air traffic congestion and reduce delays at the 25 primary air carrier airports? Second, would peak-pricing and quotas complement the technological improvements provided by the UG3RD? These two questions are addressed in the concluding chapter of the report.

7.0 Conclusions

Figures 6.1 and 6.2 represent summary results of the analysis of pricing and administrative alternatives to the UG3RD. Conclusions from the analysis are presented below.

First, peak-pricing and quotas were found, in theory, to be effective as a method of reducing air carrier congestion and delay. In fact, there were fewer delays at primary large hub airports under a system of pricing and administrative alternatives than there were as a result of UG3RD airport capacity improvements. This is shown in Figure 6.1, where, at any time in the 25-year period--1975-2000--annual system delays under a peak-pricing and quota scenario were less than delays which would be anticipated if UG3RD improvements were implemented. Moreover, Figure 6.2 shows that congestion experienced in a peak-pricing and quota scenario forced fewer cancellations of air carrier flights than there were when airport capacities were improved with UG3RD technological features.

Of all cases examined, minimum airport congestion and delay was observed when UG3RD improvements were combined with a schedule of peak-pricing and quotas. This was shown at a single airport, as well as throughout the airport network. It is concluded, therefore, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD and improve the flow of air traffic between the primary large hub airports.

While peak-pricing and quotas may offer theoretical advantages, they have limiting characteristics that must be reviewed. For example, airport quotas and other purely administrative measures, while found effective in dealing with congestion problems, tend to be biased toward maintaining the status quo when used over a protracted period of time. Because economic value is not fully taken into consideration in the implementation of a quota system, an environment can be created which: (1) protects those with rights to time slots from being displaced by others who may derive a higher economic value from the same time slots; and (2) prevents the airport from obtaining through economic mechanisms the information required to determine the need for capacity expansion or for an improved quality of service.

Administrative limitations on the use of an airport by keeping demand within acceptable bounds assures the relatively smooth operation of the facility. In effect, severe congestion can be disallowed. This state of affairs can be maintained indefinitely.

However, with access to the airport restricted and with potential users unable to indicate the true value to them of airport capacity expansion, a false sense of wellbeing can be conveyed. In effect, by arbitrarily constraining demand, artificial equilibrium conditions can be created which, in the long run, may have distorting effects on the nature, quality, and cost of the transportation service provided. These limitations are discussed further in Airport Quotas and Peak-Hour Pricing: Theory and Practice, FAA-AVP-77-5.

Similarly, the realities of a peak-load pricing system must be closely examined. The theory of peak-pricing is very persuasive. Moreover, experience has shown that a peak-pricing schedule can shift some airport user demand patterns at a given airport and time of day.

While the basic arguments which support peak-time pricing have been thoroughly reviewed in the technical literature, in practice, there are significant problems relating to implementation of peak-pricing schedules. For example, there is no accurate method for determining the optimal pricing structures, due primarily to the formidable problem of estimating elasticities and cross elasticities of airport demand to usage charges.

Furthermore, while peak-load landing charges were uniformly assessed on all airport users during congested periods, it is noted that the relative burden was not evenly distributed. When considered as a percentage of each flight's value to the aircraft operator, peak-pricing had the greatest impact on general aviation, air taxi, commuter, and all other than air carrier operators, many of which would find a peak-load pricing schedule difficult or impossible to bear.

There are some institutional issues, as well, that must be resolved before a peak-time pricing system could be widely adopted. For example, should peak-load charges be imposed by the FAA or the local sponsor? Could a peak-time pricing shedule be integrated with airport pricing agreements now in effect? Typically, airlines and airport sponsors negotiate landing fee schedules often on a long-term basis. If neither party favored a peak-pricing strategy, it is not clear how it would be instituted. Perhaps, more importantly, would the large charges needed to shift demand be politically acceptable?

By design, peak-pricing does not consider ability to pay. This is consistent with desired effects of a peak-pricing policy, of course. Those continuing to use the airport will be the ones who derive the highest benefit. However, such a pricing policy represents a radical departure from the traditional practice of free access to national aviation facilities and services. Not all sectors of the aviation community are likely to agree with such a change.

Peak-pricing and quota alternatives offer significant potential advantages. The realities of these options, however, limit their practical value at this time.

APPENDIX A

NETWORK MODEL AIRPORTS

25 PRIMARY LARGE HUB AIRPORTS

AIRPORT NAME	MODEL DESIGNATION
Chicago O'Hare	ORD
Boston Logan	BOS
San Francisco International	SFO
St. Louis	STL
Denver Stapleton	DEN
Los Angeles International	LAX
Seattle	SEA
Philadelphia	PHL
Cleveland	CLE
Atlanta	ALT
New Orleans	MSY
Minneapolis-Saint Paul	MSP
Detroit Metro	DET
Kansas City International	MKI
Dallas-Fort Worth	DFW
Honolulu	HLU
Houston	HOU
Miami	MIA
Pittsburg	PIT
Tampa	TPA
Las Vegas	LAS
Newark	NYC
Kennedy	NYC
LaGuardia	NYC
National	WAS

APPENDIX B

APPENDIX B INTENTIONALLY LEFT BLANK

APPENDIX C

TIME OF DAY PASSENGER TRAVEL PREFERENCES

FIGURE C-1
TIME OF DAY PASSENGER TRAVEL PREFERENCES
TRANSCONTINENTAL MARKETS

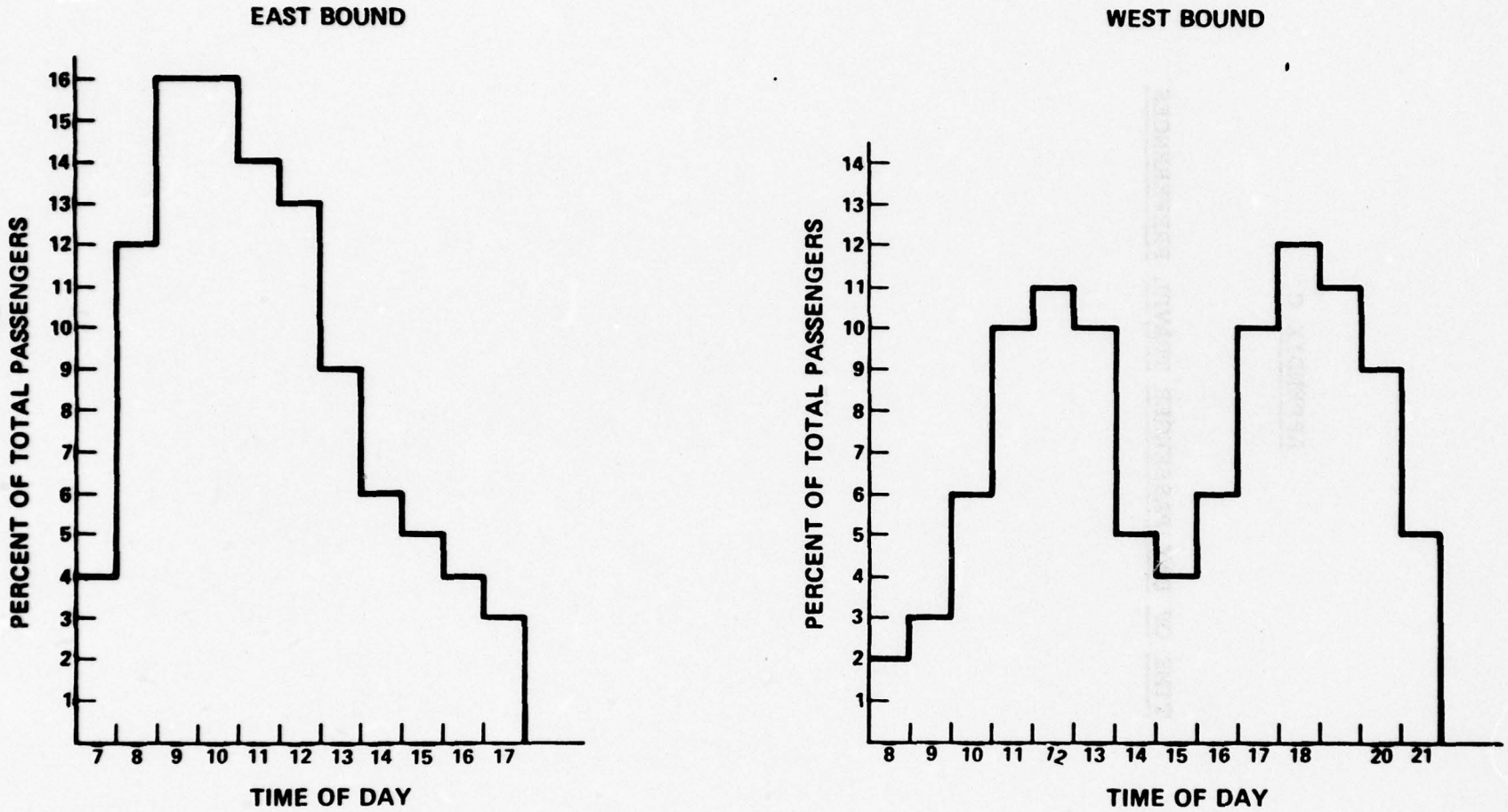


FIGURE C-2
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1800 MILE MARKETS

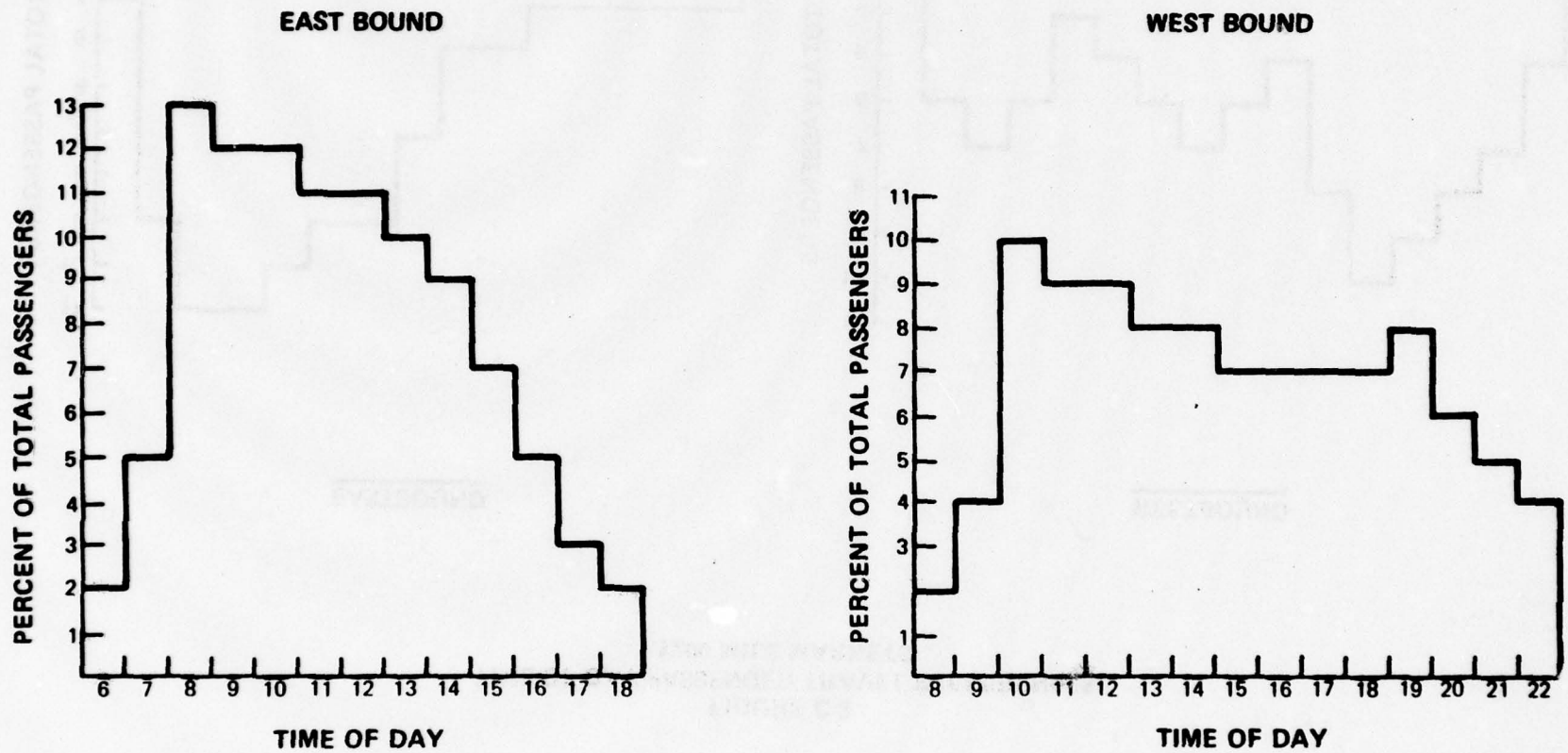


FIGURE C-3
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1200 MILE MARKETS

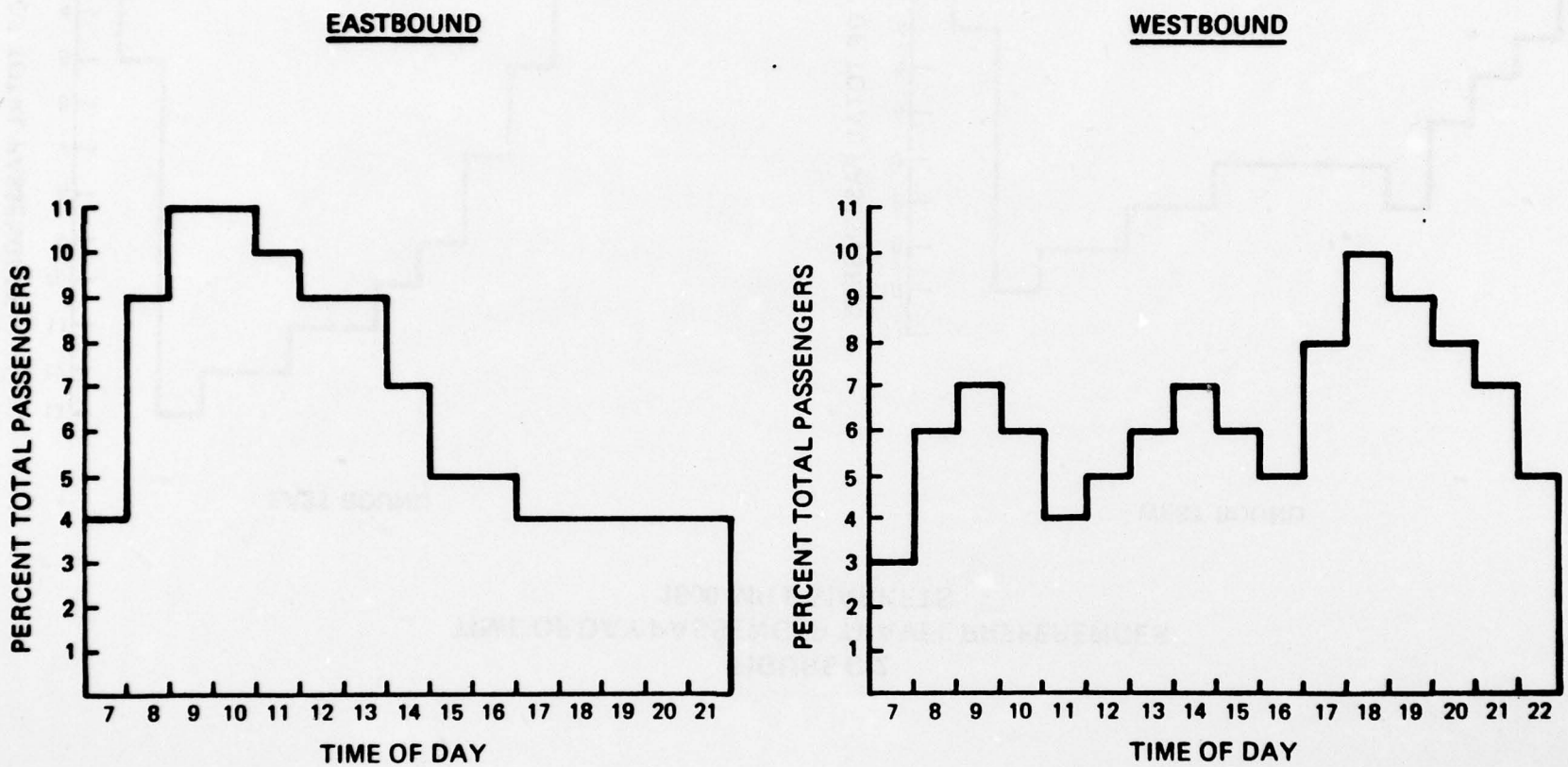
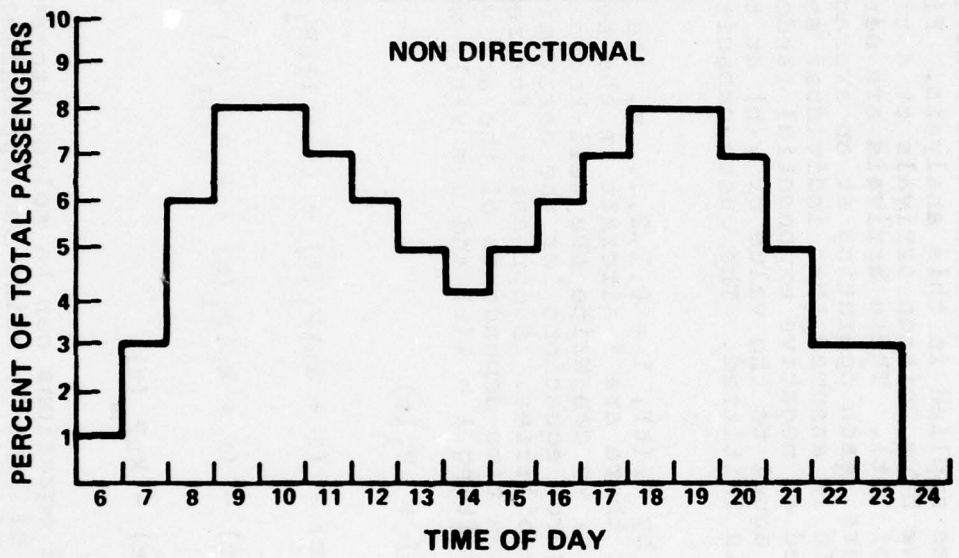


FIGURE C-4
TIME OF DAY PASSENGER TRAVEL PREFERENCES
SHORT HAUL MARKETS



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APPENDIX D

The Queuing System Equations

This appendix lists the equations that describe the two queuing systems applied in this analysis. First, for the M/M/k model, we have Poisson arrivals at a time-dependent average rate of $\lambda(t)$. These arrivals are served by k parallel servers, each operating at an average service rate, $\mu(t)$. It is assumed that individual service times are distributed as negative exponential random variables with exponent equal to the value of $\mu(t)$ at the instant t when service is initiated. The queue capacity is equal to m.

Let us define by $P_i(t)$, $i = 0,1,2,\ldots,m$, the probability that at time t there are i aircraft in the terminal area. Then, for any t, we can write the well-known set of Chapman-Kolmogorov equations for the derivatives $P_i'(t)$ of the state probabilities. Suppressing, for reasons of conciseness, the time-dependence of the arrival and service rates, i.e., writing $\lambda = \lambda(t)$ and $\mu = \mu(t)$, we have:

$$P_0'(t) = -\lambda P_0(t) + \mu P_1(t)$$

$$P_i'(t) = \lambda P_{i-1}(t) - (\lambda + i\mu)P_i(t) + (i + 1)\mu P_{i+1}(t) \text{ for } 1 \le i \le k-1$$

$$P_i'(t) = \lambda P_{i-1}(t) - (\lambda + k\mu)P_i(t) + k\mu P_{i+1}(t) \text{ for } k \le i \le m-1$$

$$P_m'(t) = \lambda P_{m-1}(t) - k\mu P_m(t)$$

The above m + 1 equations can be solved iteratively for any desired period of time T, using the approximation $P_i(t+\Delta t)=P_i(t)+P_i'(t)\cdot\Delta t$, where Δt is a time interval chosen sufficiently small to be consitent with the Poisson assumptions regarding the arrival and service processes. A boundary set of values $P_i(0)$, $i = 0,1,2,\ldots,m$, and the functions $\lambda(t)$ and $\mu(t)$ for $0 \le t \le T$ must be provided.

The M/D/k System Equations

Turning to the corresponding system of equations for the model in which service is assumed to be deterministic, we define the increment of time as equal to the duration of a single service time. We assume further that all k parallel servers begin and end service simultaneously. It is then possible to write equations relating the sets of state probabilities $P_i(t)$ and $P_i(t+1)$ - remember that t is now being increased at discrete intervals equal to the average service time. (Since time intervals are normalized to $1/\mu$, the demand rate must also be normalized to $\rho = \lambda/\mu$, the demand per unit of service.) These equations are based on the fact that the probability that exactly n aircraft will attempt to join the system between t and t+1 is equal to $\rho^n \cdot \exp(-\rho)/n!$ due to the Poisson law for the demand pattern.

We then have:

$$P_0(t+1) = \exp(-\rho) q_k(t) \tag{2.1}$$

$$P_i(t+1) = \exp(-\rho)\left[q_k(t)\frac{\rho^i}{i!} + P_{k+1}(t)\frac{\rho^{i-1}}{(i-1)!} + P_{k+i}(t)\right]$$

$$\text{for } 1 \leq i \leq m-k \tag{2.2}$$

$$P_i(t+1) = \exp(-\rho)\left[q_k(t)\frac{\rho^i}{i!} + P_{k+1}(t)\frac{\rho^{i-1}}{(i-1)!} + \ldots\ldots\right.$$

$$\left.\ldots + P_m(t)\frac{\rho^{i+k-m}}{(i+k-m)!}\right] \quad \text{for } m-k+1 \leq i \leq m-1 \tag{2.3}$$

$$P_m(t+1) = q_k(t) b_m + P_{k+1}(t) \cdot b_{m-1} + \ldots + P_m(t) \cdot b_k \tag{2.4}$$

where $q_k(t) = \sum_{i=0}^{k} P_i(t)$ and $b_j = \exp(-\rho)\sum_{i=j}^{\infty} \frac{\rho^i}{i!}$.

Strictly speaking, (2) assumes that the new arrivals during a unit of time join the queue at the end of the service unit at which time the capacity limit, m, applies.

Again, beginning with a set of initial conditions $P_i(0)$, $i = 0, 1, 2, \ldots, m$, the above set of equations can be solved iteratively to obtain numerical answers for demand and service rate profiles, $\lambda(t)$ and $\mu(t)$ (we have, for conciseness, suppressed the time variable in the equations

Related Quantities

Koopman has shown that for "relatively slow varying" $\lambda(t)$ and $\mu(t)$ the sets of equations for the M/M/k and M/D/k systems possess unique periodic solutions with period T whenever the demand and service rates are both periodic with period T. 1/ In the case of airports, demand and service rates can indeed be considered to be periodic quantities with period T=24 hours. It remains, therefore, to solve the two sets of equations numerically to obtain estimates of the state probilities, $P_i(t)$, for all $0 \leq t \leq T$. The state probabilities, in turn, can be used to compute other quantities of interest. Of those, we shall specifically refer to:

i) The probability that all runways are busy and, therefore, that a newly- arriving aircraft will experience positive delay,

$$B(t) = 1 - \sum_{i=0}^{k} P_i(t) \tag{3}$$

ii) The expected number of aircraft in the queue at time t,

$$Q(t) = \sum_{i=k+1}^{m} (i-k)P_i(t) \tag{4}$$

1/ Koopman #2

iii) The average waiting time <u>in the queue</u> for aircraft that arrive at time t

$$W(t) = \frac{1}{k \cdot \mu(t)} \sum_{i=k}^{m} (i-k+1)P_i(t) \qquad (5)$$

This last quantity is only an approximation in the case when $\mu(t)$ is a function of time. The reason is that the $\mu(t)$, may change in the future if the waiting time is long.

In all cases, two estimates of these parameters of interest are obtained, one based on the M/M/k and the other based on the M/D/k model.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Atlanta (ATL)

Year	System Package	WVAS 2/ Use	IFR Capacity 16% IFR Standard	IFR Capacity 16% IFR Crosswind	VFR Capacity 84% VFR Standard	VFR Capacity 84% VFR Crosswind
1975	Base Case	-	107.8	107.8	129.8	129.8
1980	Base Case		107.3	107.3	129.0	129.0
	UG3RD	75%	127.4	127.4	139.4	139.4
	UG3RD	25%	117.1	117.1	137.6	137.6
1985	Base Case		112.8	112.8	142.6	142.6
	UG3RD	75%	153.3	153.3	162.1	162.1
	UG3RD	25%	127.5	127.5	154.7	154.7
1990	Base Case		111.4	111.4	140.7	140.7
	UG3RD	75%	152.9	152.9	161.5	161.5
	UG3RD	25%	127.1	127.1	153.3	153.3
1995	Base Case		109.4	109.4	137.7	137.7
	UG3RD	75%	152.4	152.4	160.7	160.7
	UG3RD	25%	126.5	126.5	151.3	151.3
2000	Base Case		107.5	107.5	134.5	134.5
	UG3RD	75%	152.0	152.0	160.0	160.0
	UG3RD	25%	126.1	126.1	149.3	149.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Boston (BOS)

Year	System Package	WVAS 2/ Use	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	51.8	56.8	91.8	117.7
1980	Base Case		51.2	55.9	89.6	115.6
	UG3RD	75%	55.8	73.1	101.9	125.9
	UG3RD	25%	55.3	63.0	96.3	123.5
1985	Base Case		51.1	55.9	89.4	115.1
	UG3RD	75%	55.7	76.2	103.4	127.5
	UG3RD	25%	55.3	63.3	96.3	123.3
1990	Base Case		50.8	55.5	88.4	113.9
	UG3RD	75%	55.7	76.4	103.6	127.2
	UG3RD	25%	55.2	63.5	95.8	122.7
1995	Base Case		50.7	55.1	87.5	113.3
	UG3RD	75%	55.7	76.3	103.4	127.0
	UG3RD	25%	55.2	63.4	95.3	122.3
2000	Base Case		50.3	53.9	84.8	111.3
	UG3RD	75%	55.7	76.0	103.1	126.5
	UG3RD	25%	55.1	63.1	93.7	121.0

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Chicago (ORD)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	102.0	134.5	136.9	136.9
1980	Base Case		101.5	133.1	135.0	135.0
	UG3RD	75%	111.4	170.4	152.2	152.2
	UG3RD	25%	110.4	149.7	147.6	147.6
1985	Base Case		101.1	131.7	133.3	133.3
	UG3RD	75%	111.3	177.5	156.3	156.3
	UG3RD	25%	110.3	149.5	146.7	146.7
1990	Base Case		100.4	128.8	130.1	130.1
	UG3RD	75%	111.4	177.0	155.7	155.7
	UG3RD	25%	110.3	148.7	144.6	144.6
1995	Base Case		100.0	126.7	127.5	127.5
	UG3RD	75%	111.4	176.7	155.3	155.3
	UG3RD	25%	110.2	148.2	143.1	143.1
2000	Base Case		99.8	125.0	125.2	125.2
	UG3RD	75%	111.5	176.6	155.1	155.1
	UG3RD	25%	110.2	148.1	141.7	141.7

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Cleveland (CLE)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	51.8	51.8	73.3	73.3
1980	Base Case		51.5	51.5	72.6	72.6
	UG3RD	75%	55.7	55.7	79.7	79.7
	UG3RD	25%	55.3	55.3	78.2	78.2
1985	Base Case		51.2	51.2	71.6	71.6
	UG3RD	75%	55.6	55.6	81.2	81.2
	UG3RD	25%	55.2	55.2	77.6	77.6
1990	Base Case		50.9	50.9	70.3	70.3
	UG3RD	75%	55.6	55.6	80.8	80.8
	UG3RD	25%	55.2	55.2	76.7	76.7
1995	Base Case		50.6	50.6	69.1	69.1
	UG3RD	75%	55.7	55.7	80.4	80.4
	UG3RD	25%	55.2	55.2	75.8	75.8
2000	Base Case		50.3	50.3	67.5	67.5
	UG3RD	75%	55.7	55.7	80.0	80.0
	UG3RD	25%	55.1	55.1	74.8	74.8

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Dallas/Ft. Worth (DFW)

Year	System Package	WVAS 2/ Use	IFR Capacity 9% IFR Standard	IFR Capacity 9% IFR Crosswind	VFR Capacity 91% VFR Standard	VFR Capacity 91% VFR Crosswind
1975	Base Case	-	103.8	156.9	118.4	171.5
1980	Base Case		103.7	156.8	118.1	171.1
	UG3RD	75%	111.3	171.3	125.7	185.7
	UG3RD	25%	110.7	167.3	124.3	180.9
1985	Base Case		103.3	155.6	117.5	169.8
	UG3RD	75%	111.2	171.2	125.5	185.5
	UG3RD	25%	110.6	166.8	124.0	180.2
1990	Base Case		102.5	153.3	116.7	167.5
	UG3RD	75%	111.3	171.3	125.4	185.4
	UG3RD	25%	110.5	166.0	123.5	179.1
1995	Base Case		101.8	151.3	115.9	165.5
	UG3RD	75%	111.3	171.3	125.3	185.3
	UG3RD	25%	110.4	165.4	123.1	178.1
2000	Base Case		101.1	149.2	115.2	163.3
	UG3RD	75%	111.3	171.3	125.1	185.1
	UG3RD	25%	110.3	164.7	122.7	177.1

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Denver (DEN)

Year	System Package	WVAS Use 2/	IFR Capacity 5% IFR Standard	IFR Capacity 5% IFR Crosswind	VFR Capacity 95% VFR Standard	VFR Capacity 95% VFR Crosswind
1975	Base Case	-	52.0	59.6	59.6	106.2
1980	Base Case		58.2	60.1	94.0	107.2
	UG3RD	75%	73.9	74.0	103.2	119.7
	UG3RD	25%	63.9	64.1	99.3	113.2
1985	Base Case		57.4	59.8	92.2	103.3
	UG3RD	75%	77.0	84.7	104.2	120.9
	UG3RD	25%	64.1	64.4	98.3	112.1
1990	Base Case		56.1	58.9	89.7	100.5
	UG3RD	75%	76.6	83.8	103.8	120.4
	UG3RD	25%	63.7	64.0	96.7	110.2
1995	Base Case		55.3	68.2	87.9	98.4
	UG3RD	75%	76.3	83.1	103.5	120.1
	UG3RD	25%	63.4	63.8	95.5	108.9
2000	Base Case		54.2	57.3	85.6	94.2
	UG3RD	75%	76.1	82.4	103.2	119.7
	UG3RD	25%	63.1	63.6	94.1	107.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Detroit (DTW)

Year	System Package	WVAS 2/ Use	IFR Capacity 14% IFR Standard	IFR Capacity 14% IFR Crosswind	VFR Capacity 86% VFR Standard	VFR Capacity 86% VFR Crosswind
1975	Base Case	-	78.9	78.9	117.2	117.2
1980	Base Case		105.9	105.9	127.6	127.6
	UG3RD	75%	129.3	129.3	140.9	140.9
	UG3RD	25%	118.4	118.4	137.6	137.6
1985	Base Case		105.0	105.0	126.1	126.1
	UG3RD	75%	131.8	131.8	142.8	142.8
	UG3RD	25%	118.4	118.4	136.8	136.8
1990	Base Case		104.4	104.4	125.1	125.1
	UG3RD	75%	131.7	131.7	142.6	142.6
	UG3RD	25%	118.2	118.2	136.2	136.2
1995	Base Case		103.4	103.4	123.6	123.6
	UG3RD	75%	131.6	131.6	142.2	142.2
	UG3RD	25%	118.1	118.1	135.3	135.3
2000	Base Case		102.5	102.5	121.9	121.9
	UG3RD	75%	131.7	131.7	141.9	141.9
	UG3RD	25%	118.1	118.1	134.3	134.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Honolulu (HNL)

Year	System Package	WVAS Use 2/	IFR Capacity 1% IFR Standard	IFR Capacity 1% IFR Crosswind	VFR Capacity 99% VFR Standard	VFR Capacity 99% VFR Crosswind
1975	Base Case	-	52.0	52.0	57.0	57.0
1980	Base Case		52.6	52.6	65.1	65.1
	UG3RD	75%	73.4	73.4	76.9	76.9
	UG3RD	25%	62.9	62.9	73.4	73.4
1985	Base Case		52.3	52.3	64.3	64.3
	UG3RD	75%	77.6	77.6	79.6	79.6
	UG3RD	25%	63.0	63.0	73.1	73.1
1990	Base Case		52.1	52.1	63.8	63.8
	UG3RD	75%	77.6	77.6	79.6	79.6
	UG3RD	25%	63.1	63.1	72.9	72.9
1995	Base Case		51.9	51.9	63.4	63.4
	UG3RD	75%	77.6	77.6	79.6	79.6
	UG3RD	25%	63.2	63.2	72.7	72.7
2000	Base Case		51.7	51.7	62.8	62.8
	UG3RD	75%	77.7	77.7	79.7	79.7
	UG3RD	25%	63.4	63.4	72.6	72.6

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Houston (IAH)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	83.2	83.2	93.7	99.7
1980	Base Case		82.3	82.3	92.7	99.2
	UG3RD	75%	97.2	97.2	103.1	105.9
	UG3RD	25%	88.4	88.4	98.5	104.3
1985	Base Case		80.5	80.5	90.7	98.2
	UG3RD	75%	102.1	102.1	103.9	106.6
	UG3RD	25%	87.6	87.6	97.3	103.5
1990	Base Case		79.6	79.6	89.7	97.7
	UG3RD	75%	101.9	101.9	103.8	106.4
	UG3RD	25%	87.3	87.3	96.7	103.1
1995	Base Case		77.3	77.3	87.1	96.4
	UG3RD	75%	101.4	101.4	103.4	106.0
	UG3RD	25%	86.4	86.4	95.0	101.9
2000	Base Case		76.0	76.0	85.8	95.7
	UG3RD	75%	101.2	101.2	103.2	105.7
	UG3RD	25%	85.9	85.9	94.1	101.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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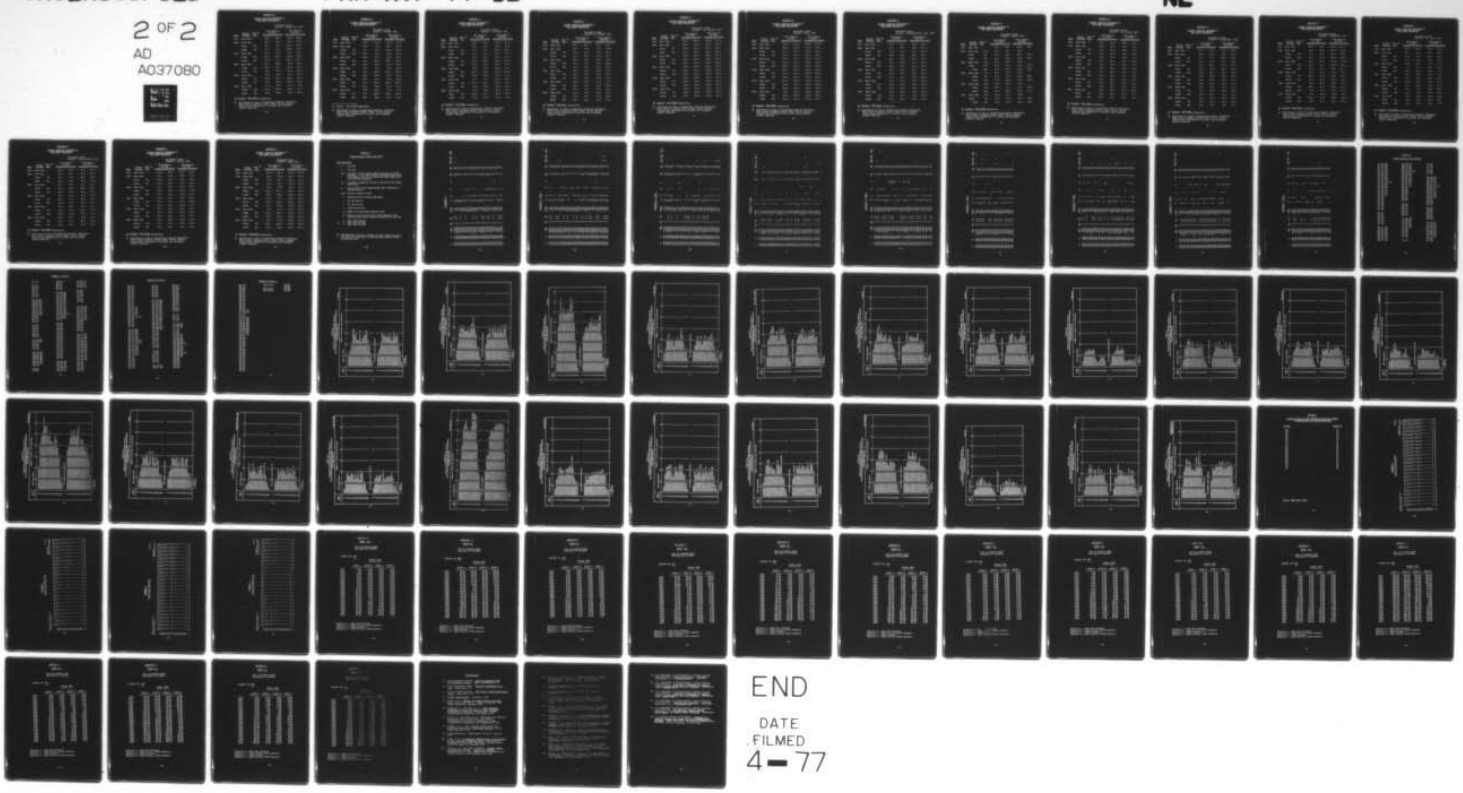

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Kansas City (MCI)

Year	System Package	WVAS 2/ Use	IFR Capacity 10% IFR Standard	IFR Capacity 10% IFR Crosswind	VFR Capacity 90% VFR Standard	VFR Capacity 90% VFR Crosswind
1975	Base Case	-	88.6	88.6	99.6	102.9
1980	Base Case		88.2	88.2	99.3	102.6
	UG3RD	75%	97.3	97.3	104.5	107.8
	UG3RD	25%	91.1	91.1	102.8	107.2
1985	Base Case		87.8	87.8	99.1	102.3
	UG3RD	75%	103.6	103.6	105.3	108.2
	UG3RD	25%	91.1	91.1	102.9	107.1
1990	Base Case		86.0	86.0	97.0	101.3
	UG3RD	75%	103.2	103.2	104.9	107.8
	UG3RD	25%	90.2	90.2	101.5	106.2
1995	Base Case		84.9	84.9	95.7	100.7
	UG3RD	75%	103.0	103.0	104.7	107.6
	UG3RD	25%	89.6	89.6	100.6	105.7
2000	Base Case		83.3	83.3	93.9	99.8
	UG3RD	75%	102.6	102.6	104.4	107.2
	UG3RD	25%	88.9	88.9	99.4	104.9

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Kennedy (JFK)

Year	System Package	WVAS 2/ Use	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	59.3	72.2	81.3	81.3
1980	Base Case		59.0	71.9	81.1	81.1
	UG3RD	75%	73.3	96.7	100.6	100.6
	UG3RD	25%	68.3	85.1	91.9	91.9
1985	Base Case		58.4	71.3	80.4	80.4
	UG3RD	75%	76.0	100.5	102.7	102.7
	UG3RD	25%	68.1	85.1	91.6	91.6
1990	Base Case		57.4	70.2	79.1	79.1
	UG3RD	75%	76.3	100.4	102.7	102.7
	UG3RD	25%	68.3	85.4	91.4	91.4
1995	Base Case		57.0	69.9	78.8	78.8
	UG3RD	75%	76.4	100.4	102.7	102.7
	UG3RD	25%	68.6	85.5	91.3	91.3
2000	Base Case		55.8	68.8	77.6	77.6
	UG3RD	75%	77.0	100.5	102.9	102.9
	UG3RD	25%	69.5	86.2	91.5	91.5

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Las Vegas (LAS)

Year	System Package	WVAS Use 2/	IFR Capacity 2% IFR Standard	IFR Capacity 2% IFR Crosswind	VFR Capacity 98% VFR Standard	VFR Capacity 98% VFR Crosswind
1975	Base Case	-	80.9	80.9	91.2	91.2
1980	BAse Case		80.5	80.5	90.7	90.7
	UG3RD	75%	97.1	97.1	102.7	102.7
	UG3RD	25%	87.6	87.6	97.3	97.3
1985	Base Case		79.6	79.6	89.7	89.7
	UG3RD	75%	101.9	101.9	103.8	103.8
	UG3RD	25%	87.3	87.3	96.7	96.7
1990	Base Case		78.4	78.4	88.4	88.4
	UG3RD	75%	101.6	101.6	103.6	103.6
	UG3RD	25%	86.8	86.8	95.8	95.8
1995	Base Case		76.3	76.3	85.9	85.9
	UG3RD	75%	101.2	101.2	103.2	103.2
	UG3RD	25%	86.0	86.0	94.3	94.3
2000	Base Case		74.4	74.4	83.9	83.9
	UG3RD	75%	100.9	100.9	103.0	103.0
	UG3RD	25%	85.5	85.5	93.2	93.2

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: La Guardia (LGA)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	59.3	61.5	73.1	78.0
1980	Base Case		57.9	59.8	71.3	75.8
	UG3RD	75%	62.0	74.0	75.8	81.5
	UG3RD	25%	62.0	64.8	75.4	80.6
1985	Base Case		56.5	58.3	69.7	73.8
	UG3RD	75%	61.4	73.9	74.6	81.9
	UG3RD	25%	61.3	64.4	74.1	79.2
1990	Base Case		55.3	56.9	68.2	72.0
	UG3RD	75%	60.7	73.6	73.5	81.3
	UG3RD	25%	60.6	63.9	72.8	77.8
1995	Base Case		54.6	56.1	67.3	71.0
	UG3RD	75%	60.3	73.5	72.8	80.9
	UG3RD	25%	60.2	63.7	72.1	77.1
2000	Base Case		53.9	55.3	66.3	69.7
	UG3RD	75%	59.8	73.3	71.9	80.6
	UG3RD	25%	59.7	63.4	71.1	76.2

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Los Angeles (LAX)

Year	System Package	WVAS Use 2/	IFR Capacity 25% IFR Standard	IFR Capacity 25% IFR Crosswind	VFR Capacity 75% VFR Standard	VFR Capacity 75% VFR Crosswind
1975	Base Case	-	106.6	106.6	167.0	167.0
1980	Base Case		106.5	106.5	166.5	166.5
	UG3RD	75%	146.9	146.9	202.0	202.0
	UG3RD	25%	125.9	125.9	185.7	185.7
1985	Base Case		105.6	105.6	164.2	164.2
	UG3RD	75%	151.8	151.8	205.6	205.6
	UG3RD	25%	125.9	125.9	184.6	184.6
1990	Base Case		104.7	104.7	161.6	161.6
	UG3RD	75%	152.0	152.0	205.4	205.4
	UG3RD	25%	126.0	126.0	183.6	183.6
1995	Base Case		104.0	104.0	159.4	159.4
	UG3RD	75%	152.3	152.3	205.4	205.4
	UG3RD	25%	126.2	126.2	182.9	182.9
2000	Base Case		84.4	84.4	131.0	131.0
	UG3RD	75%	124.8	124.8	168.9	168.9
	UG3RD	25%	103.3	103.3	150.5	150.5

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Miami (MIA)

Year	System Package	WVAS Use 2/	IFR Capacity 1% IFR Standard	IFR Capacity 1% IFR Crosswind	VFR Capacity 99% VFR Standard	VFR Capacity 99% VFR Crosswind
1975	Base Case	-	101.4	101.4	115.8	115.8
1980	Base Case		100.8	100.8	115.1	115.1
	UG3RD	75%	111.4	111.4	125.0	125.0
	UG3RD	25%	110.3	110.3	122.7	122.7
1985	Base Case		100.5	100.5	114.6	114.6
	UG3RD	75%	111.4	111.4	124.9	124.9
	UG3RD	25%	110.3	110.3	122.4	122.4
1990	Base Case		100.2	100.2	114.3	114.3
	UG3RD	75%	111.4	111.4	124.8	124.8
	UG3RD	25%	110.3	110.3	122.2	122.2
1995	Base Case		100.0	100.0	113.9	113.9
	UG3RD	75%	111.4	111.4	124.7	124.7
	UG3RD	25%	110.2	110.2	121.9	121.9
2000	Base Case		99.7	99.7	113.6	113.6
	UG3RD	75%	111.5	111.5	124.5	124.5
	UG3RD	25%	110.3	110.3	121.7	121.7

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Minneapolis/St. Paul (MSP)

Year	System Package	WVAS Use 2/	IFR Capacity 12% IFR Standard	IFR Capacity 12% IFR Crosswind	VFR Capacity 88% VFR Standard	VFR Capacity 88% VFR Crosswind
1975	Base Case	-	57.8	57.8	59.3	118.7
1980	Base Case		56.7	56.7	58.6	117.2
	UG3RD	75%	73.9	73.9	62.8	125.7
	UG3RD	25%	63.6	63.6	62.0	123.9
1985	Base Case		55.9	55.9	58.1	116.1
	UG3RD	75%	76.5	76.5	62.7	125.3
	UG3RD	25%	63.6	63.6	61.6	123.2
1990	Base Case		55.1	55.1	57.7	115.5
	UG3RD	75%	76.3	76.3	62.6	125.2
	UG3RD	25%	63.4	63.4	61.4	122.9
1995	Base Case		54.4	54.4	57.5	114.9
	UG3RD	75%	76.1	76.1	62.5	125.0
	UG3RD	25%	63.2	63.2	61.3	122.6
2000	Base Case		53.8	53.8	57.2	114.5
	UG3RD	75%	76.0	76.0	62.5	124.9
	UG3RD	25%	63.0	63.0	61.1	122.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Newark (EWR)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	51.3	56.2	58.7	78.7
1980	Base Case	51.3	56.8	58.5	79.8	
	UG3RD	75%	55.7	74.1	62.7	85.5
	UG3RD	25%	55.3	63.8	61.9	83.6
1985	Base Case	50.9	55.7	58.0	78.5	
	UG3RD	75%	55.6	76.4	62.6	87.3
	UG3RD	25%	55.2	63.5	61.6	82.2
1990	Base Case	50.7	55.1	57.7	77.7	
	UG3RD	75%	55.7	76.3	62.6	86.9
	UG3RD	25%	55.2	63.4	61.4	81.3
1995	Base Case	50.2	51.6	56.9	71.9	
	UG3RD	75%	55.8	77.1	61.9	85.8
	UG3RD	25%	55.3	64.1	60.7	75.0
2000	Base Case	50.1	53.5	57.1	75.5	
	UG3RD	75%	55.7	75.9	62.4	85.9
	UG3RD	25%	55.1	63.0	61.1	78.9

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: New Orleans (MSY)

Year	System Package	WVAS Use 2/	IFR Capacity 11% IFR Standard	IFR Capacity 11% IFR Crosswind	VFR Capacity 89% VFR Standard	VFR Capacity 89% VFR Crosswind
1975	Base Case	-	55.5	57.2	58.8	70.7
1980	Base Case		55.5	57.3	58.7	70.6
	UG3RD	75%	62.8	69.8	62.8	77.1
	UG3RD	25%	61.1	64.0	62.0	75.9
1985	Base Case		55.3	57.1	58.5	70.3
	UG3RD	75%	62.7	69.7	62.7	78.6
	UG3RD	25%	61.0	64.0	61.9	75.7
1990	Base Case		54.5	56.1	58.1	69.1
	UG3RD	75%	62.7	69.6	62.7	78.2
	UG3RD	25%	60.7	63.7	61.7	74.9
1995	Base Case		53.6	55.1	57.7	67.7
	UG3RD	75%	62.6	69.4	62.6	77.8
	UG3RD	25%	60.3	63.4	61.4	74.0
2000	Base Case		52.9	54.2	57.4	66.5
	UG3RD	75%	62.5	69.3	62.5	77.5
	UG3RD	25%	60.0	63.1	61.2	72.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Philadelphia (PHL)

Year	System Package	WVAS Use 2/	IFR Capacity 15% IFR Standard	IFR Capacity 15% IFR Crosswind	VFR Capacity 85% VFR Standard	VFR Capacity 85% VFR Crosswind
1975	Base Case	-	57.3	57.3	73.4	73.4
1980	Base Case		57.8	57.8	73.6	73.6
	UG3RD	75%	73.7	73.7	80.0	80.0
	UG3RD	25%	63.7	63.7	78.7	78.7
1985	Base Case		57.4	57.4	72.7	72.7
	UG3RD	75%	77.0	77.0	81.5	81.5
	UG3RD	25%	64.1	64.1	78.4	78.4
1990	Base Case		56.9	56.9	72.0	72.0
	UG3RD	75%	76.8	76.8	81.3	81.3
	UG3RD	25%	63.9	63.9	77.8	77.8
1995	Base Case		56.1	56.1	71.0	71.0
	UG3RD	75%	76.6	76.6	80.9	80.9
	UG3RD	25%	63.7	63.7	77.1	77.1
2000	Base Case		55.3	55.3	69.7	69.7
	UG3RD	75%	76.3	76.3	80.6	80.6
	UG3RD	25%	63.4	63.4	76.2	76.2

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Pittsburgh (PIT)

Year	System Package	WVAS Use 2/	IFR Capacity 17% IFR Standard	IFR Capacity 17% IFR Crosswind	VFR Capacity 83% VFR Standard	VFR Capacity 83% VFR Crosswind
1975	Base Case	-	87.9	87.9	101.4	101.4
1980	Base Case		87.5	89.0	100.8	100.8
	UG3RD	75%	97.2	92.4	104.7	104.7
	UG3RD	25%	90.7	92.3	104.4	104.4
1985	Base Case		84.9	87.6	99.8	99.8
	UG3RD	75%	103.0	91.7	104.2	104.2
	UG3RD	25%	89.6	91.5	103.7	103.7
1990	Base Case		82.8	87.1	99.3	99.3
	UG3RD	75%	102.5	91.7	104.2	104.2
	UG3RD	25%	88.7	91.4	103.4	103.4
1995	Base Case		80.9	86.7	98.9	98.9
	UG3RD	75%	102.1	91.7	104.1	104.1
	UG3RD	25%	87.8	91.4	103.2	103.2
2000	Base Case		79.2	86.4	98.5	98.5
	UG3RD	75%	101.8	91.8	104.0	104.0
	UG3RD	25%	87.1	91.3	103.0	103.0

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: St. Louis (STL)

Year	System Package	WVAS 2/ Use	IFR Capacity 12% IFR Standard	IFR Capacity 12% IFR Crosswind	VFR Capacity 88% VFR Standard	VFR Capacity 88% VFR Crosswind
1975	Base Case	-	59.4	59.4	75.6	75.6
1980	Base Case		59.0	59.0	74.9	74.9
	UG3RD	75%	74.5	74.5	80.9	80.9
	UG3RD	25%	64.5	64.5	79.9	79.9
1985	Base Case		58.0	58.0	73.5	73.5
	UG3RD	75%	77.1	77.1	81.7	81.7
	UG3RD	25%	64.3	64.3	78.9	78.9
1990	Base Case		56.9	56.9	72.0	72.0
	UG3RD	75%	76.8	76.8	81.3	81.3
	UG3RD	25%	63.9	63.9	77.8	77.8
1995	Base Case		55.7	55.7	70.3	70.3
	UG3RD	75%	76.4	76.4	80.8	80.8
	UG3RD	25%	63.5	63.5	76.7	76.7
2000	Base Case		54.5	54.5	68.6	68.6
	UG3RD	75%	76.1	76.1	80.3	80.3
	UG3RD	25%	63.2	63.2	75.5	75.5

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: San Francisco (SFO)

Year	System Package	WVAS Use 2/	IFR Capacity 10% IFR Standard	IFR Capacity 10% IFR Crosswind	VFR Capacity 90% VFR Standard	VFR Capacity 90% VFR Crosswind
1975	Base Case	-	52.4	54.3	76.7	76.7
1980	Base Case		52.2	54.1	76.3	76.3
	UG3RD	75%	61.2	73.6	82.9	82.9
	UG3RD	25%	59.0	63.1	79.8	79.8
1985	Base Case		51.9	53.6	75.7	75.7
	UG3RD	75%	61.3	78.0	86.0	86.0
	UG3RD	25%	58.9	63.0	79.1	79.1
1990	Base Case		51.6	53.1	74.9	74.9
	UG3RD	75%	61.3	77.8	85.7	85.7
	UG3RD	25%	58.9	62.9	78.3	78.3
1995	Base Case		51.2	52.6	74.1	74.1
	UG3RD	75%	61.4	77.6	85.5	85.5
	UG3RD	25%	58.8	62.9	77.4	77.4
2000	Base Case		51.0	52.1	73.3	73.3
	UG3RD	75%	61.4	77.6	85.4	85.4
	UG3RD	25%	58.9	63.1	76.5	76.5

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Seattle (SEA)

Year	System Package	WVAS Use 2/	IFR Capacity 16% IFR Standard	IFR Capacity 16% IFR Crosswind	VFR Capacity 84% VFR Standard	VFR Capacity 84% VFR Crosswind
1975	Base Case	-	53.8	53.8	67.5	67.5
1980	Base Case		53.6	53.6	67.0	67.0
	UG3RD	75%	73.5	73.5	77.4	77.4
	UG3RD	25%	63.0	63.0	74.5	74.5
1985	Base Case		53.6	53.6	67.0	67.0
	UG3RD	75%	76.0	76.0	79.9	79.9
	UG3RD	25%	63.0	63.0	74.5	74.5
1990	Base Case		53.1	53.1	66.1	66.1
	UG3RD	75%	75.9	75.9	79.8	79.8
	UG3RD	25%	62.9	62.9	74.0	74.0
1995	Base Case		52.7	52.7	65.3	65.3
	UG3RD	75%	75.9	75.9	79.7	79.7
	UG3RD	25%	62.9	62.9	73.5	73.5
2000	Base Case		52.2	52.2	64.2	64.2
	UG3RD	75%	76.0	76.0	79.6	79.6
	UG3RD	25%	63.0	63.0	73.0	73.0

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Tampa (TPA)

Year	System Package	WVAS Use 2/	IFR Capacity 7% IFR Standard	IFR Capacity 7% IFR Crosswind	VFR Capacity 93% VFR Standard	VFR Capacity 93% VFR Crosswind
1975	Base Case	-	82.3	82.3	117.6	117.6
1980	Base Case		80.5	80.5	116.7	116.7
	UG3RD	75%	97.1	97.1	125.3	125.3
	UG3RD	25%	87.6	87.6	123.5	123.5
1985	Base Case		78.8	78.8	115.9	115.9
	UG3RD	75%	101.7	101.7	125.3	125.3
	UG3RD	25%	86.9	86.9	123.1	123.1
1990	Base Case		77.3	77.3	115.3	115.3
	UG3RD	75%	101.4	101.4	125.1	125.1
	UG3RD	25%	86.4	86.4	122.8	122.8
1995	Base Case		76.3	76.3	114.9	114.9
	UG3RD	75%	101.2	101.2	125.0	125.0
	UG3RD	25%	86.0	86.0	122.6	122.6
2000	Base Case		75.0	75.0	114.5	114.5
	UG3RD	75%	101.0	101.0	124.9	124.9
	UG3RD	25%	85.6	85.6	122.3	122.3

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX F

NETWORK PASSENGER TRAFFIC FOR 1974 1/

Table Description

P - City name

Q - City name

PAX - Passenger in the 10 percent sample of one way on line 090 passengers. In the case of mostly connecting services total O-D passengers was used, this being the larger number due to interline-line connections.

CN - The number of competitors having at least 10% of the largest market share.

CI - The reciprocal of the largest market share (rounded up) if different from CN.

DIST- Intercity distance in miles

0 Nonstop services, including night coach

1 One stop services

2 Two stop services

C Connecting services

FQ Number of distinguishable departure times

HR Number of hours from earliest to latest departure times (excluding night coach) rounded up (usually to an even hour)

NC
0 Night coach nonstops
1 Night coach one stop
2 Night coach two stop

1/ Data comes from inspection of OAG May 15, 1974, schudule for June 1, and from Table 10 and Table 8 of the 1974 Annual CAB O-D (Origin-Destination) Tables.

APPENDIX F

P	Q	PAX	CN	CI	DIST	O	1	2	C	FQ	HR	NCO	NCI	NC2
NYC	ALT	70996	3	2.0	755	23				11	16			
NYC	BOS	201398	2	1.2	191	43				32	16	3	2	
NYC	ORD	194282	3		721	51				32	14			
NYC	CLE	61338	2	1.3	410	19				8	12			
NYC	DFW	41497	2		1363	13				9	12			
NYC	DEN	32268	2		1627	6	2	1		5	8			
NYC	DET	85138	2	1.5	489	19				14	16			
NYC	HLU	11786	1		4971	1	1	15		5	7			
NYC	HOU	35841	2		1416	7	7			9	10			
NYC	LAX	113742	3		2453	13	3	3		9	12			
NYC	MEM	13363	3	1.4	956	2	5			7	10			
NYC	MIA	159094	3		1092	30	4	3		15	10			
NYC	MSP	27758	2	1.8	1016	7	2			6	11			
NYC	PHL	9141	6		84	11				9	12			
NYC	PIT	68838	2		329	27	5			17	14			
NYC	WAS	186968	2	1.3	215	61	3			34	17			
NYC	STL	35118	2	1.5	882	9	5			10	10			
NYC	SFO	81151	3		2574	9	7	3		8	12			
ALT	BOS	14388	2	1.3	946	5	8	4		11	11			
ALT	ORD	42503	3	2.0	597	15	7	8		18	14			
ALT	CLE	17838	1		559	6	1	1		7	10			
ALT	DAL	36215	2	1.3	707	13	5	5		12	14			
ALT	DEN	3887	5		1208		1	1	15	7	12			
ALT	DET	22210	1		602	3	3	7		8	10			
ALT	HOU	20931	2	1.5	692	10				8	14			
ALT	LAX	20811	2	1.5	1934	7	2	1		7	9			
ALT	MEM	23276	2	1.5	332	11	2	3		13	12			

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	O	1	2	C	FQ	HR	NCO	NC1	NC2
ALT	MIA	36819	2	1.5	595	15	8	4		11	13			
ALT	MSP	10624	2	1.5	906	6	1	1		6	10			
ALT	PHL	22663	2		672	11				8	12			
ALT	PIT	16301	2		526	7	3			10	12			
ALT	WAS	35748	3	2.0	540	9				17	12	3		
ALT	STL	17481	2	1.5	434	9	1			8	12			
ALT	SFO	14435	1		2141	2	2	1		3	6	2		
BOS	ORD	50711	3		860	16	3	2		16	14			
BOS	CLE	15228	2	1.1	588	5	1	3		8	12			
BOS	DFW	9654	1		1543		6	2		5	12			
BOS	DEN	9372	2	1.5	1766	3	2			5	10			
BOS	DET	21925	1		623	4				5	11			
BOS	HLU	3112	1		5095			19		7	12			
BOS	HOU	5241	2	1.2	1603		2	2		4	9			
BOS	LAX	27505	2		2600	2	4			5	14			
BOS	MEM	2706	3	2.0	1139		2	3		3	12			
BOS	MIA	25264	2		1258	4	2	2		5	12			
BOS	MSP	8848	2		1124	2	3			5	10			
BOS	PHL	48283	2	1.5	274	20				16	14			
BOS	PIT	16904	2		496	6	10	2		10	14			
BOS	STL	8132	2	1.1	1046	2		3		5	9			
BOS	SFO	20404	3		2703	2	5	3		9	15			
BOS	WAS	71637	3	2.5	406	32				20	16			
ORD	CLE	49128	2	1.5	312	20	7			16	15			
ORD	DFW	41069	2		790	18	6	3		20	13			
ORD	DEN	55949	3		907	17	1	2		15	14			
ORD	DET	78413	3	2.0	238	16	1	4	4	17	15			
ORD	HLU	19282	3	1.5	4251	1	2	2		4	11			
ORD	HOU	33003	2		932	9	1			5	11			
ORD	LAX	86701	4		1740	22	8	6		18	16	3	2	
ORD	MEM	24901	2	1.2	485	8	5			11	15	1	1	
ORD	MIA	46392	3	2.0	1188	8	4	5		9	9	1		
ORD	MSP	86524	2	1.2	344	26	2	3		19	13			

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
ORD	PHL	47415	2		675	12	3			12	13			
ORD	PIT	39231	3		404	21	3			16	14			
ORD	STL	63498	3	2.0	256	23	2	6		22	16	1		
ORD	SFO	53480	3		1853	18	5			13	16			
ORD	WAS	68361	3	2.0	591	31	12	7		23	14			
CLE	DFW	7879	1		1010	2				2	7			
CLE	DEN	5221	1		1217	2				2	7			
CLE	DET	21647	2	1.5	94	16				14	13			
CLE	HOU	4623	1		1104	1		1	10	10	12			
CLE	LAX	14376	2		2046	4		2		4	16			
CLE	MEM	2408	1		628				7	7	11			
CLE	MIA	12982	2	1.5	1083	3				2	5			
CLE	MSP	6421	2	1.5	624	2	6			7	10			
CLE	PHL	17543	2	1.5	365	7				6	12			
CLE	PIT	10003	4	3.5	105	9				7	10			
CLE	STL	9579	2		492	4	2			5	11			
CLE	SFO	7683	2	1.2	2164	1	2			3	5			
CLE	WAS	20074	2		297	11	2			10	14			
DFW	DEN	29198	2	1.3	664	14	1			12	11	1		
DFW	DET	10191	2	1.3	983	3	6	1		10	13			
DFW	HLU	5407	1		3810	1			2	1	4			
DFW	HOU	46156	2	1.2	222	33				8	12			
DFW	LAX	40441	2	1.5	1248	14	1	1		9	14	5		
DFW	MEM	14118	2	1.5	410	9	3			9	12			
DFW	MIA	14404	2	1.5	1096	6	1			5	11			
DFW	MSP	9316	1		850	3	3	2		71	2			
DFW	PHL	10406	1		1289	3	3	1		6	12			
DFW	PIT	7548	1		1049	2	2			4	10			
DFW	STL	16670	2		537	9		1		7	10	1		
DFW	SFO	24912	2		1493	9	3			6	10	3	1	
DFW	WAS	18995	2		1161	8	5	4		13	10	1		

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
DEN	DET	8590	1		1144	2				2	10			
DEN	HLU	4374	3	2.3	3353		2			2	5			
DEN	HOU	18205	3	2.0	875	4	4	5		11	12			
DEN	LAX	44487	2	1.5	839	14	3	2		11	12	2		
DEN	MEM	8475	1		880	1	1	1		3	10			
DEN	MIA	5913	1	1.1	1716		3			3	6			
DEN	MSP	20962	2	1.5	693	8	2			8	11			
DEN	PHL	7930	2	1.5	1575	2	4			5	10			
DEN	PIT	4825	2		1302		2			2	12			
DEN	STL	14780	2		781	7	2			7	14			
DEN	SFO	28821	3	1.5	956	10	5	2		13	12			
DEN	WAS	15007	2	1.5	1476	5	2			5	10			
DET	HLU	2691	3	1.2	4483		1			1	14			
DET	HOU	5066	2	1.5	1095		3	1		4	12			
DET	LAX	25893	2	1.5	1977	2	4			5	6		1	
DET	MEM	7645	1		621	2	3			4	10		1	
DET	MIA	21222	2	1.5	1151	3	1	2		6	14			
DET	MSP	12383	2	1.1	534	1	5			6	12		1	
DET	PHL	21588	2		452	6				4	12			
DET	PIT	17750	3	2.3	198	8	3	1		11	14			
DET	STL	13171	1		451	4				4	10			
DET	SFO	15464	2	1.5	2086	5	1			2	16			
DET	WAS	30713	2	1.5	391	12	3	1		12	16			
HLU	LAX	88196	6	4.0	2568	12	1			10	12			
HLU	MSP	7236	2		3972		2	1	9	3	4			
HLU	PIT	2057	1		4652		1		8	2	12			
HLU	SFO	49452	4	2.2	2399	9	2			9	12			
HOU	LAX	27947	2	1.2	1372	6		3		5	12	1		1
HOU	MEM	7028	2	1.1	477	1	6	2		8	12		1	
HOU	MIA	15668	4	2.2	959	4	3	1		8	12			
HOU	MSP	4468	1		1046		1		16	2	6			
HOU	PHL	9150	2	1.5	1336	1	3			4	10			
HOU	PIT	5325	1		1124	1				1	12			
HOU	WAS	10391	3	1.5	1204	2	6	1		5	10			
HOU	STL	13069	2	1.5	677	3		1		3	8			
HOU	SFO	13300	2	1.5	1647	2	3	1		7	8		1	

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
LAX	MEM	7856	2	1.5	1606	4				3	8			
LAX	MIA	18777	4	1.5	2330	2	1	2		5	10	1		
LAX	MSP	26988	2	1.5	1526	6	2	1		10	14			
LAX	PHL	22357	3		2396	3	3	2		7	10			1
LAX	PIT	12357	2	1.3	2125	1	4	1		5	10			
LAX	STL	21902	2	1.3	1581	5	3	2		8	12	1		
LAX	SFO	111202	3	2.3	355	40	5			29	24			
LAX	WAS	34924	3		2288	6	4			8	10		2	
MEM	MIA	5462	2	1.2	861	2	1		17	6	10			
MEM	MSP	1411	3	1.2	699				28	14	12			
MEM	PHL	4620	1	1.1	881	1	2	1	15	4	11			
MEM	PIT	2474	1		652		3		10	3	11			
MEM	WAS	9022	2		754	5	2	1		8	12			
MEM	STL	15718	2		255	12				7	12			
MIA	MSP	6356	2	1.1	1501		2	2	7	4	10			
MIA	PHL	2826	2	1.5	1017	7				5	11			
MIA	PIT	13289	2	1.5	1013	4	1		16	3	10			
MIA	WAS	26463	2	1.5	920	11		2		8	10			
MIA	STL	10255	2		1068	3	2		12	5	10			
MIA	SFO	9310	2	1.5	2589	1	1	1	5	3	14			
MSP	PHL	8309	2	1.5	985	2	3	1		6	10			
MSP	PIT	3196	2	1.5	726		1	1		2	6			
MSP	STL	13733	2		448	4	3	2		8	14			
MSP	SFO	18919	2	1.5	1587	5	1	1		5	12	1		
MSP	WAS	17594	2	1.5	919	6		6		6	12			
PHL	PIT	37196	2	1.3	273	21				15	16			
PHL	STL	9205	1		820	2	1	3		6	12			
PHL	SFO	14572	3	2.2	2526	2	1	2		3	12			
PHL	WAS	20292	2	1.0	133	36	2	1		25	14			
PIT	STL	8356	2		554	7	4			10	14			
PIT	SFO	8284	2	1.3	2253	1	3			2	8		1	
PIT	WAS	21988	3	1.8	193	13	2	2		14	16			

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
STL	SFO	12293	2	1.2	1736	3	2	3		5	8	1		1
STL	WAS	18557	2	1.3	707	6	2			7	12			
SFO	WAS	26517	3	2.2	2430	5	3	3		8	10			
MSY	ALT	20983	2	1.4	425	13	4	1		8	14	3	1	
MSY	BOS	4748	2	1.6	1367	1	3	2		4	12			1
MSY	ORD	21859	1		831	3	4	2		7	10		1	
MSY	CLE	2723	1		922		2		6	6	14			
MSY	DFW	27736	2	1.3	423	10	2			9	12			
MSY	DEN	5676	2	1.1	1067	1	1	1		3	10			
MSY	DET	4626	1		936			3		3	10			
MSY	HOU	35180	4	3.0	303	17		3		14	16	2		
MSY	LAX	12229	2	1.6	1658	2	5			3	12		3	
MSY	MIA	13719	3	2.3	675	7		3		8	12	1		
MSY	MSP	2793	2	1.2	1040		2	2		4	14			
MSY	PHL	6764	2	1.6	1094	2	2	1		4	10			
MSY	PIT	4300	1		918	2				6	12			
MSY	WAS	7433	2	1.4	962	2	2			4	10			
MSY	STL	8445	2	1.2	604	2	3	2		6	12			
MSY	SFO	8010	2	1.6	1915	1	4	2		3	10			1
MSY	MKI	3942	1	1.1	676	1	2	2		4	10			
MSY	NYC	26643	2	2.0	1177	6	1	1		5	10	1		

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	O	1	2	C	FQ	HR	NCO	NC1	NC2
MKI	ALT	9954	2	1.4	681	3	2		1	4	10		1	
MKI	BOS	3511	1		1254		1		7	7	12			
MKI	ORD	47454	2	1.6	407	16		1		14	18			
MKI	CLE	3102	1		696		1		8	8	16			
MKI	DFW	16895	1		448	9	4	4		13	16			
MKI	DEN	19032	2	1.4	552	9				6	12	1		
MKI	DET	5689	2	1.8	638	3	1			4	12			
MKI	HLU	1684	4	1.7	3900				8	8	16			
MKI	HOU	6846	1		643	1	4			5	10			
MKI	LAX	19147	2	1.5	1357	6			1	4	12	2		
MKI	MIA	4796	3	2.4	1239		3	4		6	10			
MKI	MSP	11290	1		404	3	6	1		8	16			
MKI	PHL	4593	2	1.8	1040	1	2		1	4	10			
MKI	PIT	2118	1		769				10	10	14			
MKI	WAS	9647	2	1.3	932	2	4			5	14			
MKI	STL	24073	1		229	15	1			14	14	1		
MKI	SFO	9366	2	1.3	1507	3	1	1		3	10		1	
MKI	NYC	15896	1	1.0	1098	2	6	3		8	12			
TPA	ALT	30282	2	1.7	409	18	2			10	14	4		
TPA	BOS	13629	2	1.6	1182	3	3			5	10	1	1	
TPA	ORD	33180	2	1.9	1006		2	1		4	10	2		
TPA	CLE	10332	2	1.2	932	3	1			3	10			
TPA	DFW	9077	2	1.6	911	6				6	10			
TPA	DEN	3045	1		1520		2	1		3	10			
TPA	DET	22400	2	1.1	991	3		1		3	12	1		
TPA	HLU	727	2	1.2	4699				5	5	12			
TPA	HOU	3945	2	1.5	791		3		1	4	10			
TPA	LAX	5828	2	1.5	2153	1	1		13	13	12	1		
TPA	MIA	24698	4	3.0	199	10	12	2		11	12			

APPENDIX F CONT.

P	O	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
TPA	MSP	5949	1		1311		5			4	10			
TPA	PHL	12079	2	1.9	922	4	1	1		6	12			
TPA	PIT	11273	2	1.4	873	3				2	10			
TPA	WAS	10540	2	1.7	810	3	3	2		6	12			
TPA	STL	8066	2	1.6	873	3	1			4	10			
TPA	SFO	3315	2	1.9	2403				9	9	12			
TPA	MSY	6142	2	1.2	495	4			1	4	12			
TPA	MKI	2816	2	1.3	1040		2		8	8	12			
TPA	NYC	215599	3	2.0	1003	11	4	2		12	14			
SEA	ALT	3751	2	1.5	2182		1	1	8	7	12			
SEA	BOS	3765	1		2495	2			8	8	12			
SEA	ORD	21897	2	1.5	1730	7	2	3		8	14			
SEA	CLE	1770	2	1.5	2023		1		9	9	12			
SEA	DFW	7556	2	1.4	1681	3	2			5	12			
SEA	DEN	14679	2	1.6	1020	6	3			8	12			
SEA	DET	2785	2	1.4	1932		2		10	10	10			
SEA	HLU	20071	2	1.8	2678	2	2			4	12			
SEA	HOU	4077	2	1.1	1885		4			4	12			
SEA	LAX	43065	2	1.5	959	9	9	3		14	14			
SEA	MSP	9029	2	1.2	1398	4	2			6	12			
SEA	PHL	3354	2	1.2	2383		1	1		9	12			
SEA	PIT	1362	1		2124				9	9	14			
SEA	WAS	8324	2	1.5	2317	1	2		12	12	12			
SEA	STL	4830	1		1710	2	2	1		4	10			1
SEA	SFO	43624	2	1.5	671	15	8	1	12	12	14			
SEA	TPA	887	3	1.5	2527			2	6	6	12			
SEA	MSY	9029	2	1.2	1398				7	7	4			
SEA	MKI	2714	2	1.4	1501	1			10	10	12			
SEA	NYC	12531	2	1.5	2408	3	1		4	4	10			

APPENDIX F CONT.

P	Q	PAX	CN	CI	DIST	0	1	2	C	FQ	HR	NC0	NC1	NC2
LAS	ALT	4255	1		1747	1	2		5	3	11			
LAS	BOS	3659	2	1.5	2381		2		8	5	12			
LAS	ORD	34671	2	1.7	1521	8	1	1		7	10			
LAS	CLE	4873	1		1829	1			14	3	12			
LAS	DFW	16631	1		1081	4				4	12			
LAS	DEN	17969	2	1.9	616	7	1			7	12			
LAS	DET	7170	1		1758	1	2		9	4	12			
LAS	HLU	3656	2	1.4	2762		2		7	7	12			
LAS	HOU	3969	1		1229	3			2	4	12			
LAS	LAX	77383	1		227	30				17	24			
LAS	MIA	2308	2	1.4	2175			2	2	3	12			
LAS	MSP	14242	1		1300	2		1	3	2	10			
LAS	PHL	4097	2	1.6	2183	3		2		3	10			
LAS	PIT	3155	2	1.5	1910		1	1	6	6	12			
LAS	WAS	2401	2	1.5	2077	1	2		10	10	12			
LAS	STL	7899	2	1.1	1372	2	1	2		3	10			
LAS	SFO	23756	2	1.5	419	11	2	1		12	14	2		
LAS	SEA	3208	2	1.1	869		1	1	3	4	12			
LAS	TPA	1381	2	1.4	1991			1	5	6	10			
LAS	MSY	3015	2	1.9	1500		4			4	10			
LAS	MKI	5854	2	1.2	1145		4			4	10			
LAS	NYC	18853	2	1.9	2237	3	1	2		4	10			

APPENDIX G

AIRPORT NETWORK ROUTING OPTIONS

ALT WAS BOS
ALT PHL BOS
ALT NYC BOS
ALT PIT BOS
ALT STL ORD
ALT MSY DFW
ALT HOU DFW
ALT MKI DEN
ALT DFW DEN
ALT STL DEN
ALT STL MKI DEN
ALT DFW LAX
ALT TPA MIA
ALT ORD MSP
ALT STL MSP
ALT WAS PIT
ALT LAS SFO
ALT DEN SFO
ALT BOS
ALT ORD
ALT CLE
ALT DFW
ALT DEN
ALT DET
ALT HOU
ALT LAX

ALT MIA
ALT MSP
ALT PHL
ALT PIT
ALT WAS
ALT STL
ALT SFO

BOS PIT DFW
BOS NYC DFW
BOS PHL DFW
BOS WAS DFW
BOS CLE DFW
BOS STL DFW
BOS CLE DFN
BOS DET DEN

BOS ORD DEN
BOS STL DEN
BOS MKI DEN
BOS LAX HLU
BOS DEN LAX HLU
BOS SFO HLU
BOS ORD LAX
BOS MKI LAX
BOS PHL MIA
BOS WAS MIA
BOS DET MSP
BOS NYC PIT
BOS PIT STL
BOS ORD
BOS CLE
BOS DEW
BOS DEN
BOS DET
BOS HLU
BOS HOU
BOS LAX

BOS MIA
BOS MSP
BOS PHL
BOS PIT
BOS STL
BOS SFO
BOS WAS

CLE DET MSP
CLE ORD MSP
CLE ORD STL
CLE ORD SFO
CLE STL SFO
CLE MKI SFO
CLE DFW
CLE DEN
CLE DET
CLE HOU
CLE LAX

CLE MIA

CLE MSP
CLE PHL
CLE PIT
CLE STL
CLE SFO
CLE WAS

DEN LAX HLU
DEN SFO HLU
DEN MKI PHL
DEN STL PHL
DEN PIT PHL
DEN MKI STL PIT
DEN MKI PIT
DEN MKI PIT
DEN MKI STL
DEN LAS SFO
DEN STL WAS
DEN MKI WAS
DEN DET
DEN HLU
DEN HOU
DEN LAX

DEN MIA
DEN MSP
DEN PHL
DEN PIT
DEN STL
DEN SFO
DEN WAS

DET SFO HLU
DET LAX HLU
DET DFW HOU
DET STL HOU
DET LAS LAX
DET ORD LAX
DET DEN LAX
DET ORD MSP
DET CLE PIT
DET HLU
DET HOU

DET LAX

DET MIA
DET MSP
DET PHL
DET PIT
DET STL
DET SFO
DET WAS

DFW STL DET
DFW ORD DET
DFW MKI MSP
DFW WAS PHL
DFW PIT PHL
DFW STL PIT
DFW LAS SFO
DFW DEN SFO
DFW ALT WAS
DFW DEN
DFW DET
DFW HLU
DFW HOU

DFW MIA
DFW MSP
DFW PHL
DFW PIT
DFW STL
DFW SFO
DFW WAS

HLU SFO MSP
HLU SFO PIT
HLU LAX
HLU MSP
HLU PIT
HLU SFO

HOU TPA MIA
HOU ALT PHL
HOU WAS PHL
HOU MSY WAS
HOU ALT WAS
HOU LAS SFO
HOU DFW SFO
HOU LAX

HOU MIA
HOU MSP
HOU PHL
HOU PIT
HOU WAS
HOU STL
HOU SFO

LAS DFW ALT
LAS NYC BOS
LAS CLE BOS
LAS STL BOS
LAS ORD DET
LAS LAX HLU
LAS STL PIT
LAS DEN PIT
LAS STL WAS
LAS MKI STL
LAS SFO SEA
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LAS DEW MSY TPA
LAS DFW MSY
LAS DEN MKI
LAS ALT

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LAS PIT
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LAS SFO
LAS SEA
LAS TPA
LAS MSY
LAS MKI
LAS NYC

LAX DFW PHL
LAX MKI PHL
LAX STL PHL
LAX DEN PHL
LAX DEN PIT
LAX ORD PIT
LAX STL PIT
LAX DEN STL
LAX LAS STL
LAX MKI STL

LAX MIA
LAX MSP
LAX PHL
LAX PIT
LAX STL
LAX SFO
LAX WAS

MIA ORD MSP
MIA STL MSP
MIA TPA MSP
MIA TPA STL
MIA ALT STL
MIA TPA SFO
MIA MSY SFO
MIA DFW SFO
MIA MSP
MIA PHL
MIA PIT
MIA WAS
MIA STL
MIA SFO

MKI STL ALT
MKI PIT BOS
MKI CLE BOS
MKI STL CLE
MKI ORD CLE
MKI ORD DET
MKI DFW HOU
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MKI ORD PIT
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MKI NYC
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MSP CLE PHL
MSP ORD STL
MSP CLE PIT
MSP DET PIT
MSP DET CLE PIT
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MSP SFO
MSP WAS

MSY PHL BOS
MSY PIT BOS
MSY WAS BOS
MSY STL ORD
MSY ALT CLE
MSY DFW DEN
MSY ALT CLE DET
MSY STL ORD DET
MSY STL DET
MSY DFW LAX
MSY STL MSP
MSY ORD MSP
MSY LAS SFO
MSY DFW SFO
MSY STL MKI
MSY ALT
MSY BOS
MSY ORD
MSY CLE
MSY DFW
MSY DEN
MSY DET
MSY PHL
MSY PIT
MSY WAS
MSY STL
MSY SFO
MSY MKI
MSY NYC

NYC ORD DEN
NYC STL ORD
NYC MKI ORD
NYC SFO HLU
NYC LAX HLU
NYC STL HOU
NYC ALT HOU
NYC PIT HOU
NYC MKI LAX
NYC DEN LAX
NYC ORD MSP
NYC DET MSP
NYC PIT STL
NYC ORD STL
NYC CLE STL
NYC DEN SFO
NYC ORD SFO
NYC ALT
NYC BOS
NYC ORD
NYC CLE
NYC DFW
NYC DEN
NYC DET
NYC HLU
NYC HOU
NYC LAX

NYC MIA
NYC MSP
NYC PHL
NYC PIT
NYC WAS
NYC STL
NYC SFO

ORD LAX HLU
ORD ALT MIA
ORD CLE
ORD DFW
ORD DEN
ORD DET
ORD HLU
ORD HOU
ORD LAX
ORD MEM
ORD MIA
ORD MSP
ORD PHL
ORD PIT
ORD STL
ORD SFO
ORD WAS

PHL PIT
PHL STL
PHL SFO
PHL WAS

PIT CLE STL
PIT ORD SFO
PIT STL SFO
PIT STL
PIT SFO
PIT WAS
SEA MKL ALT
SEA STL ALT
SEA ORD CLE
SEA DEN DFW
SEA DEN DFW
SEA ORD DET CLE
SEA ORD DET
SEA DEN HOU
SEA DFW HOU
SEA ORD PHL
SEA ORD PIT PHL
SEA ORD WAS
SEA MKI STL
SEA ALT
SEA BOS
SEA ORD
SEA CLE
SEA DFW
SEA DEN

MSY HOU
MSY LAX
MSY MIA
MSY MSP
SEA PHL
SEA PIT
SEA WAS
SEA STL
SEA SFO
SEA TPA
SEA MSY
SEA MKI
SEA NYC
SFO WAS
STL MKI SFO
STL DEN SFO
STL SFO
STL WAS
TPA PHL BOS
TPA STL ORD
TPA ALT ORD
TPA MSY DEN
TPA DFW DEN
TPA MSY HOU
TPA DFW LAX
TPA ORD MSP
TPA STL MSP
TPA ALT WAS
TPA ALT
TPA BOS
TPA ORD
TPA CLE
TPA DFW
TPA DEN
TPA DET
TPA HLU
TPA HOU
TPA LAX
TPA MIA
TPA MSP
TPA PHL
TPA PIT
TPA WAS
TPA STL
TPA SFO
TPA MSY
TPA MKI
TPA NYC

ORD STL MIA

ORD SFO HLU
ORD TPA MIA

SEA DET
SEA HLU
SEA HOU
SEA MSP

TABLE H-1
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

ATLANTA

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDD	D					
8	DDDDDDDDDD	DADAD					
9	DDDADDDADA	DDADDADAAD	A				
10	DDDDAAADDD	DDDAAADADA	ADDDAADDDD	DAAA			
11	AAAAADADDA	DADDDAADAD	DAAADDAAAD	DA			
12	DDDADDADAA	DAAAADDDAD	DAAADAADAA				
13	DAADDAADAA	ADDDADDAAD	ADDA				
14	DAADDDADAA	ADADDADDAA	DAAD				
15	AAADDDAADD	ADAAAAADAD	ADDDDDDAAD	DDA			
16	ADAAADAAAA	DADAAADDDD	AA				
17	DADADADAAA	DDADDAADDD	DADDDA				
18	ADDDAAAAAA	DDDADAADDD	AAADDDAAA				
19	DDDDDDADDA	ADAAADDDAD	DAAAADADDA	AA			
20	DAAADDDADD	DADDDAADAA	AAADADDAAD	DA			
21	AADADDDDAA	DADAAAAADD	DAAA				
22	AAADDAAAAA	AADAAADADD					
23	DAAAAAAAAA	AA					
24	AAAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	DD					
8	DDDDDDDDDD	AADDDD					
9	DDDDADAAAD	ADDDDDAADA	DA				
10	DDDAAAADDD	DDDAAAADDD	DAADAAADDD	A			
11	AADAAADDDA	ADADDDDDAD	DAAADADAA				
12	ADDADADAAD	ADAADADADA	AAAADDA				
13	DDADDDAAAA	ADDADDAAAD	ADDDADDDA				
14	AAADDDDDAD	ADAAAAAAAA	DDADDA				
15	DDDAADAADD	DDAAAAAAAD	ADDDDDDAAA				
16	AADDDAAAAD	ADADADAADD	DDDADA				
17	DAAAAAAADD	DAAADDADDD	DDD				
18	DDDAAADAAD	DDDAAAAAAD	DAADAADDDA	A			
19	DDADDDADAA	ADAADDDAAD	ADDDAA				
20	ADDAADDAAA	DDDAADAADA	DADDADDAAA				
21	DADAADAADD	DDDAADDDAA	ADDDAAAA				
22	AAADADDADD	AADAAAADDA					
23	AAAAAAAAAA	AAAA					
24	AAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-2
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

BOSTON

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO	10	20	30	40	50	60
6							
7	DDDDDDDADD						
8	DDDDAAADDD	DADDDA					
9	DDDDAADAAD	DAADDADADD	DAADDDDA				
10	DDDAADADDD	AAADAADADD	DADAAAADDD	A			
11	DDAAADDDAD	DAAADDAAAD	DDDAADDDAD				
12	DAAAADDAAD	AAADADDAAA	ADDAADAADA	A			
13	DDADADADAD	AAADDAAAAD	DDAAADA				
14	DADAAADDAA	DADDDAAADA	AADDDDD				
15	DAAADDDDAD	DADDADDAAA	AAADDAADD				
16	AAADAADDAA	ADDDAAAAAA	DDDDA				
17	DDDAADAADD	AADDDDAADD	DAAADDAAAD	A			
18	DDAADDDDAA	ADDDAAAAAA	DDDADDADDA	DAA			
19	DDAADDDDAA	DDDAAAAAAD	DADAADDDAD	DADAAADDDA			
20	DAADDDDDAA	DDDDAAAAAD	DAADDDADDA	A			
21	AADDAADAAD	AADDAAAAAD	DDDA				
22	ADDDAADAAA	AAA					
23	DDAADAADAA	A					
24	AAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	DDADD					
8	DADADADDAD	DDDADDAAAD	DDD				
9	ADAADDADDA	DDDDDDAADD	ADAA				
10	DDAAADDADD	DAAADDDAAA	DAADDDDDDA				
11	ADDAADDAAD	DAAADDDAAD					
12	DAADADDAAD	DADDDAADAD	DAADDADDAA				
13	DADADDAADA	ADDDDAAADA	ADAAD				
14	AADDDDAADD	AADAAAAADD	DDDDDDADDD	A			
15	AAADADDAAD	AADAAADDAD	DAAAA				
16	DDDDDAAADD	DAAAAAADDA	ADDDDADDAA				
17	DDADADDAAD	DDAAAAADDA	DDAAA				
18	DDAADDDDAA	DDAAAAAAAA	DADDDDDAAD	D			
19	DAAADADAAD	AADDDAAAAA	DDAAA				
20	DDAAADDDDD	ADDAADDDDD	AAAAAAADDD	D			
21	DDADDAAADD	AADDADDDDA	AAADAADADD	AA			
22	DDAADAADDA	DAADDAAADA	A				
23	AAAAAAAAAA	AAAAA					
24	AAAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-3
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

CHICAGO

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES								
	BASE CASE SCENARIO								
	10	20	30	40	50	60	70	80	
6									
7	DADDDDDDDD	DDDAAADDDD	DADA						
8	DADDDADDAD	DADDDDDDDA	AAAADDDDDD	ADDAA DDADD	ADDDA				
9	DDDDADDDDA	AADDAAAADD	DDDAADDDAA	DDDDDDDDAA	ADDADDAAAD	DDDAAAAAA			
10	DDDAAADDDD	DADDDDBAAD	DDDDDDAADD	DADDDDAAAD	DAAAAADDDD	AAAADDADDD	DDDAAADDDD	DAA	
11	DDDDAAAAAD	DDAAADDDDA	DDDDDDDAAD	DAAADDDAAA	DDAADAADDD	DDDAAADA			
12	DDDDAAADDD	DAADADAAAA	DDDAADDDDD	AADDAAADAA	DDAADDDDDD	DAAADAAADD	AAAA		
13	DDDDADDDAA	AADAAADAAD	DAAADDDDDD	DDDAAADAAA	DDDDDADDAA	AAAAADDDDD	A		
14	DDAADAAAAA	DDAADDDADD	AAAAADDDAA	AAADDADAAD	DAAADDAADD	AAAAADDA			
15	DDAAAADAAA	DAAADDDDDD	DADAADDAAA	AADADDADDA	ADDAAAAAAA	ADAAADDDDD	AA		
16	DDDDAAAADA	AADAADDDDA	AAAAADDDDA	ADDDDAADDA	AADAAAAADD	AAADDDDDA			
17	DDAAAAAAAD	DADDDDDAAA	DAAADDDDAA	AAADDAAADA	DDDDAAADAA	AADAADDDDD	DA		
18	DDDDDAAAAD	DDAAAAADAA	AAADDDDDAA	AADDDDADAA	AAAAAADDDD	AAAAAADDDD	DDDDDAAADA	AAAA	
19	DDADDDAAAA	DAAAADAAAD	DDDDAAAAAA	DADDDDDDDD	DDDAAAAADA	ADDDAADDDD	AAAADDDAAA	A	
20	AAADDAADDD	AADDAAADDD	AAADDDAAAA	ADDAADAAAD	DDDDDAAAAA	ADAAADDDAA			
21	DDDAAADDAA	AADDDDAADD	DAADAADADA	AADDDAADAA	AAADDAAAA				
22	DDDDDADDAA	ADAAAADAAA	DAAAADAADA	A					
23	AAADAADAAA	AA							
24	AAAA								
	PEAK PRICING & QUOTAS SCENARIO								
6									
7	DADDDDDDDD	ADDDDDDADD	DDDDAAAADD	DDDADA					
8	DDDAADDDDD	AADADADDDA	ADDAADDDDA	AAADDAADD					
9	DAAADDADDD	DADDADADDD	DDADDAAADA	ADDDDADAAD	AADD				
10	DDADADDAAA	DDDAADAADD	DAAADDDAAA	DDAADDADDD	DAAAA				
11	DDDAADDAAD	DDDAADDADD	AAADDAAADD	DADDDDAADD	AAD				
12	DAADDDDDAA	AADDAAADDD	DDDDAAAADA	AAAADDADDD	AADDDAADA				
13	DDAADDDAAA	AADDDAADAD	DDDAAADDDA	ADDAADDAAA	ADDDAADDAA				
14	DAAADAADDD	DAAADDAADD	DDDAAAADDA	AAADAAAADD	DDDDDDAAAD	DDAA			
15	DADDDDDAAA	AADDDAAAAD	DAADDAAAAD	DDAADAADDA	DDDAAAA				
16	DAAADAADDD	DAADDDDDAA	AADDAAAADD	DAADAADDDA	AADDDAADDA	A			
17	DDAAADDADA	AAADDDDAAD	DDDAAAAAAA	DDAAADDDDA	AADDDA				
18	DDDDDAAADD	DDAAAADDAA	ADDDDDAAAA	AAADAADDDD	AADDDDAADA	A			
19	DDADAAAADA	DDDAAAADDD	DADAAAADDD	DDAAAAAADD	DADAAAA				
20	DDDDDAAAAD	DDDAAAAADD	DDDAAADAAA	ADDDDDDDDA	DDADAADDDA	AADAA			
21	DDAAAADAAA	ADDDADDDAA	DDDAADDDAA	ADADDDADAA	AAAAAADDDD	DDDDAAAA			
22	DDDDDDADAA	DDAAADDDAA	AADADDAAAA	AAAAAAA					
23	AAAAAAAAAA	AAAAA							
24	AAAAAAAAAA	AAA							

A: ARRIVAL
B: DEPARTURE

TABLE H-4
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

CLEVELAND

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDDDD						
8	DADDDDAADA	AD					
9	DDDDDADAAA	DDDADDDDDD					
10	AAADDDAAAD	AADDDDADDA	AADDA				
11	DAADDADDDD	DAADAAAADA					
12	AADDDAADDA	ADDDDDDDAA					
13	DAAAAADDAD	DDDDAAAAAD					
14	DDAADDADAA	DDDAD					
15	AAAADDAADA	DAAAADADDD					
16	DAADDADDAA	ADDDADAADA	AA				
17	DDADDDDAAA	AAAADDDDDD					
18	ADAADDAAAD	AADDDADADA					
19	DDAAADADDA	DDAAADDADD	AADADDAAAD				
20	DDADDDADAA	AAADADDADD	ADAA				
21	ADDAAADDAA	AAAAAAA					
22	DDDDADAADA						
23	DDAAAAAAAA	AA					
24	AAA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDDDDD						
8	DDADADDAAA	DDDDD					
9	AADDADADDD	DDADDDAAAD	D				
10	AADADDDAAD	ADDDDADAAD	AAA				
11	DDAADDADDD	DDAADAAAA					
12	DADDDDAADD	AAAAAADDAD	ADD				
13	DADADADDDA	DDAAAA					
14	AADDDADDAD	ADDAAAADAA					
15	ADADDDDDDA	AAADAADADA	ADAD				
16	DDDDDAAAAA	DDAADDDDDA					
17	AADDADAAAA	DDDAADDADD	AA				
18	ADADADDDAA	DDDAAAAAAD	A				
19	DAADADDDDA	DDAAAADDAA	DAA				
20	DADDDDDDDA	AAADAADDAA	DADDAA				
21	DADADADADA	AAAADAAADA	A				
22	ADDDDADDAA	ADAA					
23	DAAAAAAAA						
24	AAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-5
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

DALLAS/FT. WORTH

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDD						
8	DADDDDDDDD	DDDDAAADDA	DDDD				
9	ADDDADDDDD	AADDDDDAAD	DDDDAAD				
10	DADAAADDDD	ADDADDDDAA	ADDADDDDDD	DAA			
11	DADDAADAAD	DDDDADDADD	DDADAADADD	DAAADAA			
12	DDAAAADDAD	AAAADDDDDD	DAADDDADDA	DADDDAA			
13	DAAAADAADD	AADDAADDAD	AADDAADDD				
14	AAADDADDAA	ADADDAAADD	DAAADAADDD	AA			
15	DDDADDAAAA	ADDAAADDAA	AAADADADDD	DA			
16	DADDAAAADD	AAADDDAAAD	DDAA				
17	AADDDDAAAD	DDAAAADAAD	AAAAADAADD	DDADAA			
18	AADDDDADDD	AAAADAADDA	DAAAAADDAD	AA			
19	DDADADDDDD	AADAADAAAA	AADAADADDA	ADDDA			
20	DAAADDDAAD	DAAADAADDA	DAADAADDDD				
21	AAAAAAADDA	AAAADADDAD	DAAAAA				
22	AADAADAAAA	AAAAADDAAA					
23	DAADAAAAA						
24	AAAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	DDD					
8	DDADDDDDDD	DDDDAAADDA	ADDDD				
9	DDDAADDDDA	DDDDDDAADD	DDDDAADDA				
10	DDAADAAAAA	DDDDAADDDD	DDDDADDDAA				
11	DADDAADADD	DAAADDDDDA	DAAADADAAD	AA			
12	DDAAADDADD	DDAADDDDAA	ADAADAAADD	DDAAA			
13	DDADDDDADA	AAAADDADAA	ADDDAA				
14	DADDDADADD	DAAADDAAAD	AADDDAADDD	A			
15	DDAADDAAAD	DDAAAAADD	DDADAAA				
16	DDAAADDADD	DDAAADDDAA	DDAADDAA				
17	ADAAAADDAD	DADDAADAAA	DDAAADDADD	AA			
18	ADDAADDAAA	AAADDDAAAD	ADDDDADA				
19	DDAADAADDD	AAAADAAAAA	DAAADDDDDA	ADD			
20	DDADDDDDAA	DAAADAADAA	DDAADAAAAD	DDA			
21	DAADDAAADA	AAAADDAADD	AAAAAD				
22	AAADDDAAAD	ADAAAAAADA	DAAAAAAA				
23	DAADAAAAAA	AA					
24	AAAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-6
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

DENVER

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDDDDDD	DDD					
8	DDADDDDDDD	DADDADDDA					
9	DDDDAADDAD	DDDAADDDDD	DD				
10	DAADADDDDD	ADDDDDAADD	AAADDAAAAD	AA			
11	DDAAADDADD	DDDADDDDDA	DDADDDADDA	AAAAAA			
12	DDDAAAADAD	DDDDDAAAAA	DDDDADAA				
13	DAAADADDDA	DAADDAAAAA	DDDADDADDD	A			
14	DDDDAAADAA	DAADADDDAA	DAAA				
15	DADDAADAAA	ADDADDDAAD	DDADDA				
16	AAADDAAAAA	DAAADDDDAA	ADADAAAD				
17	DAADAAAAAA	AADDDDDDAD	D				
18	DAAADAADAD	AAAADAADDA	DDA				
19	DAAAADDAAA	DDAADDAAAA	DDAADAA				
20	AAADAADDDD	DDADAAADAD	ADA				
21	AADADAAADA	ADAADDAA					
22	DAADAAAAAA	AAAA					
23	AAAAAAA						
24	AA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDDDDD	DDDADDD					
8	DDDDAAADDA	DDDDAADA					
9	DDDADDDAAA	DDDDDDDDA					
10	DAADAAADAA	DADAADDAAA	DDDDAADAAA				
11	DAAADDDADD	DDAADDDADD					
12	DAAADDAAAA	ADDADDDDAA	AADDD				
13	AAADAADDDD	DDAADDDADA	ADAAAD				
14	ADDADDAAAD	DADDAAAAAA	DDDDA				
15	DAADDDDDAA	ADDAADDAAD	DDAA				
16	AADDADAAAA	ADAADDDDDA	ADDDA				
17	DDDDADDAAA	AAADDAADDD	ADAA				
18	DAADAAAADD	AADADDDDDA	ADDDDAADD				
19	AADADADDAA	AADADDDDA					
20	AADDDAADAD	ADADAAAADD	AA				
21	ADDADDDDDA	AADDAADAAD	A				
22	DDDAADAAAD	AAAAAAAAAA					
23	AAAAAAAAA						
24	AAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-7
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

DETROIT

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDD						
8	DDADDDDDDA	DDDAD					
9	AAADDDDDDA	AADDDDDDDA	DAA				
10	DDDDDAAADD	AADDDDAADD	DAADAAADDA	AAAD			
11	DDDADDDAAA	DDDDAADDDA	ADDAAAAADA				
12	AADDDDDAAD	DDDDAAAAAA	ADAD				
13	DDDDADAADD	DAADDAAAAD	ADDAAD				
14	DDDAAADAAD	DADDDAAAAD	A				
15	AAADDDDDDA	AAAAAAAADD	DDDDAAA				
16	DDADAAAADA	DDDDDAADDD	AA				
17	DAADAADAAA	ADDDADDDAA	DDDDAAAD				
18	DDDAAAAADD	ADDAADDDAA	AADDDAAADA				
19	DDADDDAADA	AADDDADDAD	DADAAAAADD	AA			
20	DDDAADDDDA	AADADADADA	DDAAADDAAA	AA			
21	DAAADDDADA	DADAAAADAA	AAA				
22	DDAAAADADD	AAAAADD					
23	AADDAAAAAA	A					
24	AAAAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	D					
8	DDDDADDDDA	ADDDDDADA					
9	ADDDAAADDD	DDAADDDADD	A				
10	AAAAADDADD	DADDDADDDA	AAADDDA				
11	AADDADDDAD	AADDAADADD	DADDADADA				
12	DAAADDAADA	AADDDADDAA	DDAAAADDD				
13	DADAAAAAAA	DDDDDADDAD					
14	DADDAADDAD	ADAADADADA	DDDAAAA				
15	AADDDAAADA	AAAADDDDDD	DAAA				
16	DAADADDAAA	ADDAAAADDD	DA				
17	DDADDADADA	AADAADDDDD	AAAA				
18	DDADADDAAA	DADADAADDD	ADDDAAA				
19	ADDDADDDAA	DADADDAAAD	ADAADAAADA	AA			
20	DDDDDAADDD	DAAADADDAA	AADAAAA				
21	DAAADDDDDD	DAAAADDAAA	DAADADA				
22	DAADDDDAAA	AAADAAADDA					
23	ADAAAAAAAA	A					
24	AAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-8
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

HONOLULU

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO	10	20	30	40	50	60
6							
7	DDDDD						
8	DDDDDDDDDD	D					
9	DDDDDDDDDD	DDDD					
10	DDDDDDDDDD	DDD					
11	DDDDDDAADD	DDDDDD					
12	DDDADDDDAA	DDADD					
13	DADDAADDDA	DAAA					
14	DDAAADAADD	AADAAA					
15	DAAADAADAA	DDADD					
16	AAADAAAA						
17	AAAAA						
18	AAAA						
19	AAAAAA						
20	AAAAAAAAAA	A					
21	AAAAAAAAA						
22	AAAAAAAAAA						
23	AAAAAA						
24							
	PEAK PRICING & QUOTAS SCENARIO						
6	DD						
7	DDDDDDDDDD						
8	DDDDDDDDDD	D					
9	DDDDDDDADD	DA					
10	DDADADDDAA	DDADA					
11	DDDDADDADD	DADDAADDA					
12	DDDADADDAD	DDDA					
13	AADDDADDDA	ADDDA					
14	DDADDAADDD	AADDDAA					
15	DDADADDDAD	AADDA					
16	AAAAAA						
17	AAAAA						
18	AAAAA						
19	AAAAAAA						
20	AAAAAA						
21	AAAAAA						
22	AAAAAAA						
23	AAAAA						
24	AAAAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-9
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

HOUSTON

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDD						
8	ADDDDDDADD	DADADDDD					
9	DDDADDDDAA	DDAADDDAAA					
10	DDDADDDDDD	DADDDADDAD	DDAA				
11	DDAADAADDD	DDADDAADAD	AAAADAA				
12	AADDDADADD	DDDDDAAAAD	ADAA				
13	DDADDDDAAA	DAAAADDADD	A				
14	ADADDAADAD	ADADADDDAA	DDA				
15	DDAAAAADDD	AADDDDDAA					
16	ADADDAAADD	DAAAADAA					
17	DDAAAAADDA	DAADDDAADD	AAA				
18	ADAADDDADA	ADAAAADAA					
19	DDAADDAADD	ADDADAADAA	A				
20	DAADAADDAD	AADAAAAADD	D				
21	DDAAAAAAAD	DAADAAAAAA					
22	DAAAAAAADA						
23	AADAAA						
24	AAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD						
8	ADDDDDADAD	ADDD					
9	DDDAADDDDA	DDDDDAAAAA	D				
10	DDDADDDDDA	ADDDDAADAD	ADA				
11	DAADDDDADD	AAADAAAADD					
12	ADDDAAAADA	DDDAADDDDD	DAAA				
13	DDADDAADAD	DAADAAAD					
14	DAAADDAAAD	DAADDDDDAD					
15	DADDAAADAD	DAADADDA					
16	AADDDAADAD	DAADDAD					
17	AAAAADDDAD	AAADDDDAAA	ADA				
18	DAADDAADDA	DAADDAA					
19	AAADDDADAD	ADAADADDAA					
20	DAADDAAADA	DDADADAAAD	DD				
21	DDAAAAAAAA	ADAAAAAD					
22	DDDDAAAADA	AAAA					
23	AADAA						
24	AAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-10
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

KANSAS CITY

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDD						
8	DADDDDDDAD	ADDA					
9	ADDDDDADDD	AADAADD					
10	DDAADDDDAD	DADADADADD	D				
11	ADADDDAAAA	ADDDDDDDDD	AAAA				
12	AAAADADDDD	DAADADAAAD	DA				
13	DDDDAADADA	ADDADAD					
14	AADAAADDDA	ADAADAAD					
15	DAADDDADDA	DAAADADA					
16	ADDDDDAADA	DAADADDA					
17	DAAAADAAAA	DDAAADADDD	DAA				
18	DDDAAAAADD	DDAAADD					
19	DDAAADAADD	AAADDAADDA	ADA				
20	ADDAADADAD	DDAAAAAADA	DD				
21	AADAADADAA	AAAADDAD					
22	AAAAAAADDA	D					
23	ADAAA						
24	AA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDD						
8	DADDDDDDAD	DADAADD					
9	DADDADAADD	DDADDA					
10	DADADADADA	DDDDDDAA					
11	ADAADADDAA	DAADDDD					
12	AAADDDAAAD	AADDAADAAD	DDD				
13	AADDDADAAD	DDDA					
14	AAADAADADD	ADADDAAA					
15	AAADADDADA	ADADDAD					
16	DDADDDDDAA	AADADA					
17	DDAADAADAD	AAAADDADDA					
18	DDDAADAAAD	AAAADDDA					
19	DADDADDDAA	AAAAADADDA					
20	DDAADDAAAD	AADAADDAA					
21	ADADDADAAD	DDADAA					
22	AADAADDAAA	DADAAA					
23	AAAAAAAA						
24	AA						

A: ARRIVAL
B: DEPARTURE

TABLE H-11
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

LAS VEGAS

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDD						
8	DDAADDDDDD	ADAADDD					
9	DDDDDDADDD	AAADD					
10	DDDDDDDAAD	DADDDAAADD	D				
11	DADDADAAAD	DADDADAADA	ADDA				
12	DAADDDADAA	DDDDADDAAA	D				
13	ADAAAADDDA	DAADDDD					
14	ADDADAAAAD	DADADADA					
15	DAADAAAADA	DDDDDDD					
16	ADADAADDDA	A					
17	AAADADDAAA	DAAA					
18	ADADDADDAA	AAAAA					
19	DDDAADDAAA	AAAADAADDA					
20	AADADAAADA	ADA					
21	AAAADDAAAA	AA					
22	ADAAAAADA						
23	DA						
24	AA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDADD	DDA					
8	DDDAADDDAD	A					
9	DADDDDADAA	DDAD					
10	DDDADDDDAD	DDAADADDAA					
11	DADADAADDA	DAADADDDA					
12	DADADDAADD	DDAAAA					
13	DDDADAADAA	ADDDAADD					
14	DADDAADAAD	DDAAADAA					
15	ADDADDADDA	DADADA					
16	AADDADDADD	DDA					
17	AAAADAAADD	DADDA					
18	AADAADDADD	AAA					
19	ADAADAADAA	AAADDDA					
20	ADAAADAAAA						
21	DDAADADAAA	DA					
22	DAAADAADAA	AA					
23	AAA						
24							

A: ARRIVAL
B: DEPARTURE

TABLE H-12
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

LOS ANGELES

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDD	DDDDDDDDDD	D				
8	DDDDADDDDD	DADDDDDDDD	DDDADDDDDD	DAADDDDDDD	D		
9	DDDDDDDDDD	DDDADDDDDA	DDDDADDDDD	DDDDADDADD	DDDADDDD		
10	DDDADDADDD	DDADADDDDD	ADDADDDDDD	DDDDADDAAA	DDDADDDADD	DA	
11	DDDDDDAADD	DDDAADDDDD	DDAAADDDDD	DDDAAAAAAA	DDDDDADDDA	DDDDDADDDD	DAAAA
12	DAAADDDDDD	AAADDDDDDA	AAADDADDDD	DADADDDDAA	DDAADDDAAD	DDDDAAA	
13	DDDDAAAADD	DDADAAADDD	DDDAAADDAA	ADADDDDDAA	ADAADDDDAA	DADDDDAA	
14	DDAADADDDA	DDAAAAADDA	AADAADAADD	DAADDDAAAA	DADDADAAA		
15	DDDAADDAAD	DADAAAAADD	DAADDAAAAA	ADDDAADDDD	DAAAAAAADA	A	
16	DDAAADDDDA	DDDAAAAADD	AADDAAAAAA	DAAADDDDDA	AAAA		
17	DAAAADADDD	DADAAADDAA	AAAAAADDAA	ADADAAAADD	AAA		
18	AAAADADAAA	ADDDAAAADA	AAAADADAAA	DAAADDAAAA	A		
19	DDDAAAAADD	ADAAAAAADA	ADAAAADDAA	AAAAAADDAA	AAAADAAAAD		
20	AAAADADAAA	DAAADAAAAD	AAADAADAAA	AADAAAADAA	ADDAA		
21	AAAAAAAAAA	DAADADAAAA	AAAAAAAAAA	DAAAAAAA			
22	AAAADAAAAA	AAAAAADAAA	AAAAAAAAAA				
23	AAADAAADAA	AA					
24	AAAAAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6	D						
7	DDDDDDDDDD	DDDDDDDDDD	DDDDDDDDDD	ADDDDD			
8	DDDDADDDAD	DDADDDDDAD	DADADDDDDD	DDDAADDAAA			
9	DDDDDAADDD	DDDAADDDDD	DDAAAADDDA	ADAAADDDAA	ADDDDDA		
10	DAADDDADDD	DAADAADDDD	DDAAADDDDD	AADAADDDDA	DDDAAADDAD	AAA	
11	DADDDAADDA	DDDDAADDDD	DADDDADAAA	DAADAADDDD	DDDDAAADDA		
12	DAADDDDAAD	AAAADDDAAD	DDDDDDADDD	ADADDAADDD	AADDDAADDD	DAAA	
13	DDDDADDDAA	AAADDDDDAA	DDDADDADAD	AAADDDDDAA	DDADDDDA		
14	DAAAADDADD	DAAADDDDDD	AADADDADDD	ADDDAAAADD	DDAAAAADDD	A	
15	DDDDADDDDA	AAAADADDDD	DDAAADDDDD	DAAAAADADA	ADDDAADDAA	ADDDAAAA	
16	ADDDAAAADD	AADDADAAAD	ADDAAAADDD	DAAAAAAAAA			
17	DDAADDDDAA	ADDAAAADDA	AAADAADDDA	ADDAAADAAA	ADADDA		
18	DDAAAAADDD	DDDAAAAADA	AADDDAAAAD	ADDDDDAAAD	AAAAAA		
19	DDADDDAAAA	DDAAADDDDA	AAAADADAAA	DAADDAAAAD	A		
20	DAAAAAAAAA	ADAADAAADA	AADAADDAAA	AAAAA			
21	DDDAADADAA	AAADDDDDDD	AAADAADAAA	AAAAAADAA			
22	DAAADAAADA	AAAAAAAAAD	ADAAAAAAAA	A			
23	AAAAAAAAAA	AAAAAAAAAA	AAAAAAA				
24	AAAAAAAAAA	AAA					

A: ARRIVAL
B: DEPARTURE

TABLE H-13
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

MIAMI

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDDDDDD						
8	DADDDDDDDD	DDDDDD					
9	DADADDDDDD	DDDADDDADD	A				
10	DDDDDDDAAA	DDDDDDAAAA	ADADDDADDA				
11	DADDDADADA	ADDDAAAADA	AADADADA				
12	ADDDDDAAAA	ADDDDDADAA	DDAADDAAAA				
13	DDDAADDDAA	DAAADDDAAA	DDAADDAADD	AA			
14	DDDDADDADD	AAADDDAAAA	ADAA				
15	DDDAADDAAA	ADDADADADD	AADDAAADDD	DAAA			
16	AADDAADAAA	DDAADDADA					
17	DAAADDAAAD	DAAADADDDA	AAADDADDDD	AAA			
18	DADAADDDDA	ADDADAADAD	DDAAADAAA				
19	DAAADDDDAA	DDDADDADDA	AAA				
20	DDDAAAADDA	ADADADADDA	ADAAADAAA				
21	ADDDADDAAA	AADDDDADAD	AAAAD				
22	AAAAAAAAAA	DAA					
23	DAAAAAAAAA	AAA					
24	AAAAAAA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDDDDD						
8	DDDDDADDDD	DDDDDD					
9	DDDADDDDAD	DADDDDDAD					
10	DDDADDAAAD	DDAADDDAAD	ADDADDADDA				
11	DDAADDAAAD	ADAAADDDAA	DDDAADAA				
12	DADDDAADAA	DDAADDADDD	ADDAADA				
13	DAAADAADAA	DAADDAADDD	DAADDAADAA				
14	DDDDAADDAA	ADADDDAAAD	ADA				
15	DDAADADADD	AAADDAAAAD	DDDDDDAAA				
16	ADAADDADAA	DAAAAADDAD	A				
17	DADAAADDDD	AAAAAADDDA	ADDDDDAAA				
18	DDDDAAADDA	DADDAAADDA	ADDDADAAA				
19	ADDAAADDDD	DDAAADDADA	AA				
20	DDAAADDDAA	ADADDDADAD	AADAAAAA				
21	AAADDDDDDD	ADDDDDAAAD	DAAAADAAA				
22	ADADAAAAAA	ADDAA					
23	AAAAAAAAAA	AAAA					
24	AAAAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-14
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

MINNEAPOLIS/ST. PAUL

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDA						
8	DDDDADD						
9	ADADDDDDDA	DDDADADADD	ADDA				
10	DDDDDDDAAD	AAADADD					
11	DDADDAAAAD	AADADAAA					
12	DDDDDADAAA	DDDDDADADA	ADDDA				
13	AADADADAAD	ADADADDDAA					
14	ADDAADDAAD	AAAADDA					
15	ADDDAAAAAA	ADDDD					
16	DDADDADAAA	DADDAADAA					
17	ADAAADAADA	ADDDAADDDD	AD				
18	DAAADADDDA	DADAADADAA	AA				
19	ADDDADDDAA	AADAA					
20	DDDADDAADD	AAAAAADAAA	DDAAA				
21	DDADAADAAA	DDAD					
22	AADADAAA						
23	ADAA						
24	A						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDA						
8	DDADDDDDAA	D					
9	DDADDDADAD	DDAADDDDDA					
10	AADDDDDDAA	AAADDD					
11	DAADDDADDA	AAAADDDAA					
12	ADDDADADDD	DAAADAAADD					
13	DDDDDAAAAA	DDDAADAD					
14	ADDDAAAAAA	DDDDDDADA					
15	AADAADDADA	AADD					
16	AADDDDAAAA	ADDDADDADA	A				
17	DAAADAADAD	ADDDDA					
18	DADAADADDA	DDAADADDAA					
19	AADDAADDDA	AAADA					
20	DDADDADDDA	DAAADAAAAD	DAA				
21	DADDAADADA	AAADADDDA					
22	ADDDADAAAA	AAA					
23	AAAAA						
24	AAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-15
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

NEW ORLEANS

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES (10, 20, 30, 40, 50, 60)						
BASE CASE SCENARIO							
6							
7	DDDDD						
8	DADDDDDAAA	DD					
9	DADDDDADDD	AAAADADDDD					
10	DDADDDAAAD	AADDDDAA					
11	ADADADADDA	AADDDA					
12	DAADDAADDA	AAAAADDDD					
13	DDDADDAADA	ADAAADDAA					
14	DADDDDDAAA	DAA					
15	DADDDDAAAA	AAADDDDDA					
16	ADDADDAADD	AAAD					
17	ADDAAADAAA	DDDDDDDAAA					
18	DAAADDDAAA	DD					
19	DAAAADDAAA	DDAAADDDAA	A				
20	DDDDDAAAAA	DDDADADAAD					
21	AAADDAADAA	A					
22	AAADAAAADA						
23	DAAA						
24	A						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDD						
8	DDADDDDDAA	ADDD					
9	ADDDAADDDD	AAAADADD					
10	DADDADDAAA	DDADA					
11	DAADAADDAA	ADDDDDA					
12	DADAAAADDA	AADDDDDD					
13	ADAAADDDAA	A					
14	AADDAAAAAD	AADADDDDDA	A				
15	DDDDDAAAAA	DDA					
16	ADDAADDADA	DAAD					
17	DDDAADAAAD	ADDADA					
18	DDADAAADDA	DDDAAA					
19	AADDDDAADD	AAADAD					
20	ADDDDAAAAA	AADDADDAD					
21	ADADDAADDA	DAADA					
22	AADAADA						
23	DAAAAAAAA						
24	AAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-16
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

NEW YORK CITY

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES								
	BASE CASE SCENARIO								
	10	20	30	40	50	60	70	80	
6									
7	DDDDDDDDDD	DDDDAADDD							
8	DDDDDDDDDD	DDAAADDDDD	DDDAAADDDA	ADDDDDDDAA					
9	DDADDDDDDD	ADDDDDAADD	DAADDDDDAD	AADDDAADDD	DDAADDDDDA	DAADAA			
10	DDDDDDDAAA	DAAADDAAAD	DDADDDDDAA	DDDDAAAAAD	DDDDAAADDD	AADDDAAADD	DAAADAADDA	AA	
11	DDDDDAAAAD	DAAADDAAAD	DADDDAAAAA	ADDDDDAAAA	DDDAAAAAAD	DDADAAAAAD	DDAAAADDAA	ADDDAA	
12	DDAAAADDDD	ADDDDDAAAA	ADDDDAAADD	DAAAAADDAA	AADDDAAAAD	DDDAAAADDA	AADDDAADDD	AAAAADDDDA	A
13	DDDAAAAADD	ADDDAAAAAA	AAADDDDDDA	AADDDDADDA	AAADDAAAAD	DDDAAAADDA	AAAADAADDD	AAA	
14	DDAAAADDDD	DDAADDAAAD	AAAADDDDDD	ADDAAADDAA	AAADDDDAAA	AADDDAAADD	DAADDAAAAA		
15	DAADAAAADD	DAAADDDDDD	AAADAADDDD	AADDDDDAAA	ADDAAAAAAA	AAADDAAAAD	DAAADDDDD		
16	DDDDAAAAAA	DADAAAAAAD	DDDADDAAAA	AAADDAAAAD	ADDDDDDDAA	AADDAAAAAD	DDAADAADAA	AAA	
17	DDDDDDAAAD	DDAAADDDDD	AAAAAAAADD	DDAAAAAAAD	DDDADDDAAA	AADDDAAAAA	ADDDDDDAAA	DDDDAAADDD	DDAAAADD
18	DDDAAADDDD	DDAADDDDAA	AAAADDDDDA	ADADDDDDDA	AAAADDDDAA	AADDDDDDDA	ADDAAAAADD	DDDDAAAADD	DDAAAAAD
19	DDDDDDDDDA	DDDAAAAADD	DDDAADDDAA	AAAADDDAAD	DAAADDDDAA	DDDDDDAAAA	DDDAAAAAAD	DDDAADDAAA	DDDDDA
20	DDDDAADDDD	DDAAAAADDD	DDDDAAAAAA	ADDDDDAADD	DAAADAAADD	DDDDAAAAAA	DDDDDADDAA	AAADAAAADD	DDAAA
21	DAAADADDDA	AAADDDAAAD	DAADAADDDD	AAAADDDADD	DDAADDDAAD	DADDDAA			
22	DDDDAAAADA	AADAADAAAA	DAADAAAAAA	AAAAAA					
23	DDDAAAADDA	AAAAAADDAA	AAAAAAA						
24	AAAAAAAAAA	AA							
	PEAK PRICING & QUOTAS SCENARIO								
6									
7	DDDDDDDDDD	DDDDDDDDDD	DDDDAADDDD						
8	DAADDDDDDD	DDAAADDDAD	DDDDDDDDAD	DAAADDDDDD	DAADD				
9	DDDADDDAAD	DDDDDDDADA	AADDDDDAAD	DDDDDAAADD	AADDAA				
10	DDDDDDAAAA	DADDAADDDA	ADDDADAAAD	DDDDDAAAAA	DDDDDAADDA	ADDDAAADDD	DAAAA		
11	DAAAADDDDD	AADAAADDDA	ADDDDAAAAD	DDAAADDDAA	AADDDAAAAD	AAAADDDADD	DDAAAAAADD		
12	DDDAAAADDD	DAADDDDAAA	DDDAADAAAA	DDAAAADDDA	AAADDDAADA	AAADDDDDAA	DDAAAAADDA	A	
13	DDDDDAAAAA	DDDAAAAAAD	DDAADDDDDD	AADAADDDAA	AADDDDAAAA	DAAADDDAAA	AADDADDDD		
14	DDAAAAAAAD	DDDAAADAAD	DAAAADDDDD	DADAAADDAA	AADDDDAAAD	DDDADAAADD	DDDDDDAAAA	AAA	
15	DAAADDDAAA	AADDDAAADD	DDAAAAAAAA	DDDDDDAAAD	DDDAAAAAAA	AADDAAAADD	DDAAADDAAA	DDDDAAA	
16	DAAADDAAAD	DDDDAAAADD	ADDAAAAADD	DAAAAADDAA	ADDDDDDAAA	DDAAADDAAA	DDADDAAAAA	AAAA	
17	DDDDDDADDA	ADDDAAAAAD	DDDDAAADAA	AADAAADDAA	AAADDDDADD	DDDDAAAAAD	DDDAADDDAA	ADDDAAAA	
18	DDDDAAADDA	ADDDDDAAAD	DDDAAADDAA	AADDDDDAAD	DDAAADDDDD	AAAADDDDAA	DDDAAAAADA	AADAAAA	
19	DDDDDDDAAA	ADDDDDAAAA	DDDAADDDDA	AAAAADDDDA	AAADDDAAAD	DDDDAADAAA	DDDDDAAAAD	DAADAA	
20	DDDDDAAADD	DDDDAAAAAD	DDDDADAAAD	DDAAAADDAA	DDAADDDDDD	AAAADDDDDA	AAAADDDDAA	AAAADAAA	
21	DAAAADDAAA	AADDDDADDD	DAAAADDDDD	AADDDDAADD	AAADDDDDAA	DDDDDDAAAD	ADDAAADDDD	DAAAA	
22	DDDADDAAAD	DDAAAAADAA	ADDAAAAAAD	AAAAAADDDA	AAAAAAAA				
23	DAAAADDAAA	AAAAAAAAAA	AAAAAAAAA						
24	AAAAAAAAAA	AAA							

A: ARRIVAL
B: DEPARTURE

TABLE H-17
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

PHILADELPHIA

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDDD						
8	DDAADDDDAD	ADDDD					
9	ADDAADADAD	DDDDDADA					
10	DDDAAADDDA	AAADDADDDD	AAADD				
11	DDAAAADDAA	DDDAADDDAA	DDDAAA				
12	ADAAAAADDA	ADDADDAADA	DDA				
13	DADDAAADDD	AAADDDADDA	AAA				
14	AAADDAAADD	DDADAAADD					
15	AADAADDDDD	ADDAADAAAD	AADD				
16	DADAAAADAA	AADDDDDDAA	ADDAA				
17	AAADDADDAD	DDADAADADA	AADADA				
18	DDDADDAAAD	DADAADDDDA	AADADAA				
19	DDDDDAADAA	DADAAADDDA	AADDADDAAA	DAADDA			
20	DDADDDADAD	AAADADDDAA	DADDA				
21	ADADDADADA	DADAAA					
22	DDAAADADAA	AAA					
23	ADDAAAAAAA	AA					
24							
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDDDDD	D					
8	DDDAADAADA	DDAAADDDDD					
9	ADADDDDDDD	AADDA					
10	DADAADDDDD	AADADAAAA					
11	DDADDDDDAD	DDADAAAAA					
12	DAADADDDDA	DAADDDDDA					
13	DDADDAADAA	AAADADADDD					
14	DAADAADDAA	ADAADDDDDD	A				
15	ADDADAAAAD	DAADDADAAD	A				
16	DAADDAAAAD	DDDDADDDDA	A				
17	ADDAAAAADD	DDAAAAAADD	A				
18	ADDAADDDDD	DAADAAAADD	AA				
19	DAAAAADDDD	DAAADDDAAA	A				
20	AADDDDDDDA	AADAAAAADD	DDDD				
21	DADAAAAADD	DDDDADDDDA					
22	AAADDDAAAA	AAADDAAAAA					
23	AAAAAAAA						
24	AAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-18
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

PITTSBURGH

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDD						
8	DDDDDAADDD	ADADDDD					
9	DAADDDADDA	ADDDDADDAD	DDA				
10	DDADDDDAAA	AAADDAADDD	DAA				
11	DADDDDDAAA	DDDADDAADA	AADAA				
12	DDADADDDAD	AAAADDAADA	ADDD				
13	ADDAAADDAA	DDDAAAA					
14	ADADDAAADA	DDAD					
15	AADDDDDDDA	AADADADDAD	DAA				
16	AAADDAAAAD	DADDADADDA	A				
17	AADDDDDADA	ADDADAAD					
18	DAADDADADA	DAAAADDADD	ADDAD				
19	DDAAADADDA	ADDADAADAA	DAA				
20	DADDDDDAAD	DAAAADDDAD	DADAA				
21	DAADADAAAA	AADADDA					
22	DDADDAAAAA	ADAAAA					
23	DDDAAAAAA						
24	AAA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDD						
8	DDDDDAAAAD	DDDDDDADDD					
9	AADDDAADDA	DAADDA					
10	DDADADADDD	ADADAADAAD	A				
11	ADDADADDDA	ADDDADAA					
12	DDAAAADADD	ADAAADDAAA	DDDDD				
13	DADAADAADD	AAAAD					
14	DDADADAAAD	AADDDDDAAA	A				
15	DDADDDAAAD	DADADAAD					
16	DAADAADAAA	AADDDAAADD	DDD				
17	DDDDADDAAA	AADADAAAA					
18	DDADDAADDD	DDAADAAA					
19	ADDAADADDD	DAADAAADAA	A				
20	DAADDDDDAA	AAADADDDDD	AA				
21	DAADADADDA	AAADADDAAA	DAA				
22	DADDAADDAA	AAAAA					
23	ADAAAAA						
24	AAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-19
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

ST. LOUIS

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDA	DDA					
8	DDDAADDDAD	DDDADADDD					
9	AAAAADDDDA	DDAADDADDA	DAADADDAD				
10	DDDDDDAAAD	DADDAADAAA	ADDDDADDDA	ADD			
11	DDDADDDAAA	ADAAAADDAA	ADAADDDDAA	ADDA			
12	DADDDAADDA	DDDADAADDD	AAADADD				
13	AADAADDADD	AAAADDDDDA	AAADAADAA				
14	DADAAADDAD	ADDAADADAD	DDDAA				
15	DAADDDDADA	ADAAAADAAA	DDDAAA				
16	DADADDDADD	ADDADDAAAD	A				
17	AADDDDDAAA	DADADAADD	DADDAAADDD	AAA			
18	DDADDAAAAD	AAADDAADAD	DDDDAADAAA				
19	DDDDDAAAAA	AAADADADDA	DDAADDAA				
20	DADDDDDDAA	AAADDAADAA	DADDAAADAD	DAAADDDA			
21	AAADAAADDA	DAAADADAA					
22	DADADADDAA	AAADAAA					
23	ADADAAAA						
24	AAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	AADDDDD					
8	DDDADAAAAA	DDDADDADDA	AAADDDDDA				
9	AADADADDDD	AADDAADADA					
10	DADDDDDAAA	DDDAAADDDA	AADDDDDD				
11	AAAAAAADAA	DADDDDADDD	ADDAAA				
12	DAADAADDAA	DAAADDDADD	DDAAAADDA				
13	DAAADDDDAA	ADDADADAAA	DDADA				
14	ADAAAADDDD	DDAADDADAA	DDDDDDAAD				
15	AADADDAAAD	AAAADDAADD	ADDDDDAA				
16	DAAADADDAA	AADADAAADD	DDAA				
17	DDDAADADDD	DAAAADDAAA	DAADDDA				
18	DDDADAAADD	DDAAAAADAD	ADDDDDAAAA	A			
19	ADDAAAAADD	DDADDDDAAD	DDAD				
20	AADDDDDAAA	AAAAADAADA	DAADDDDADA	A			
21	DDDAAADDDD	DAADAADDAA	DAAADDDAAD				
22	AADDDADDDD	AAAADDAAAA	AAA				
23	AAAAAAAAAA	A					
24	AA						

A: ARRIVAL
B: DEPARTURE

TABLE H-20
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

SAN FRANCISCO

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDD	D					
8	DDDDDDADDD	DDDDDDDDDD	AADDDDDDDD				
9	DDDDDDDDAA	DDDDDDADDD	DDADADDDDD				
10	DDADDDDDDA	DDDADDDDDA	DDDDDDADDD	ADDDADD			
11	DDDDAADDAD	DDAAADDADD	DDDADDAADD	DADDDAAAAA			
12	DDDDDDADDD	DDADDDDDAA	AAADDDAADA	ADDDAADDD			
13	AAADDDDDDD	DDAAAAAAAA	DAADDDADDA	AAAADDDA			
14	DDDADDADAA	DDDAADAADA	DAADAAADDA				
15	DDDAAAAAAD	DDDAADAADD	AAADDDAAAD	ADDDA			
16	DAAADAAAAD	DAADAADDAA	AAADDDDA				
17	AAAADDAAAD	AAAAADADDA	AAADA				
18	DAAADADAAA	DADDADAAAA	AADDAADAAA				
19	DDADAAAADD	AADAAAADAA	AAADDAAAA				
20	AADDAAADAA	AAADDADAAD	AAAAADAAD				
21	AAAAAADAAA	DAAAAAAAAA	DAAAADAA				
22	AAAAAAAAAA	ADAAAAAADA					
23	AAAAAADAAA						
24	AAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	DDDDDDDDDD	DDDD				
8	DADDDDDDDD	DDDDAADDDD	DDAA				
9	DDDDADDADD	ADDDDDAADD	DAADADDD				
10	DAADDDAAAD	DDDAAADDDD	DDAAADDADA	ADDDDDAA			
11	DDADADAAAA	DDDDAADAAD	DDDDAADADD	ADD			
12	DAADDDDAAD	DDDDDAADDA	AADDDDDAAD	ADA			
13	DDDAADDAAD	DADAAADDDD	DDADDDAAAD	DADDDDDA			
14	AAAADDDADD	DDAADDDADD	DDDADAADAA	ADA			
15	DDDADDDDAA	AAAADDDDAA	DADDADDAAA	DDADDD			
16	ADAAAAADDA	DDAAADADDA	DAADAAAAA				
17	DAADAAAADD	DADAAADADD	DAAADDAA				
18	AAAADAADDD	ADDDDAAADD	AAADDDAAAA	AA			
19	DDADDADAAA	DAADDAADAA	DAAAA				
20	ADDAAAAADD	AAADAADDAA	AAADA				
21	AAAAADADDA	DDADDAAAAD	AAA				
22	AAAADAADDA	AAAAAADAAA	AAA				
23	AAAAAAAAAA	AAAAAAAA					
24	AAAAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-21
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

SEATTLE

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES (10 20 30 40 50 60)
BASE CASE SCENARIO	
6	
7	DDDDDDD
8	DDDDDDD
9	DDDDDDADDA DDDDDA
10	DDDDDDADAD DA
11	DDDDDAAAAD DDADADD
12	DADDDADDAD DADDDAAA
13	ADDAAAADDD DAAADDDADA
14	DDDDAAADAA A
15	ADDDAADADA DADDDD
16	ADAAAADDAD DA
17	ADAAAAADAA DAA
18	ADAADAAADD A
19	DAAAAADAAD DAAA
20	AAAADAADDA AA
21	DAAAADAAA
22	AAAAAAA
23	AAAAA
24	A
PEAK PRICING & QUOTAS SCENARIO	
6	
7	DDDDDDDDDD D
8	DDDDA
9	DADDDAADAA ADD
10	DDDDADADD
11	AAADDDAADD DDAAD
12	AAAADDDDDD DAADA
13	DDADDADADD AA
14	ADAAADDDAA AADDDAA
15	DDDDDDADAA A
16	DADDADAAAA ADA
17	DDDDADAADD ADAA
18	ADAADADDAD DDD
19	AAADDAADDA
20	AAADAAAAAA AD
21	DDDAADADA
22	AADAADAAA
23	AAAAAAAAA
24	AAA

A: ARRIVAL
B: DEPARTURE

TABLE H-22
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

TAMPA

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	10	20	30	40	50	60	
BASE CASE SCENARIO							
6							
7	DDDDDD						
8	DDADDDDDDD	DDDADDDD					
9	DDADDDADDD	DDDDAAA					
10	DDDDAADADD	DAAADADDDD	AADAA				
11	DADAAAADDD	AADDDADAAA	DDAAAAADD				
12	ADDDDDAADD	DDAAADAADD	DAAAA				
13	DDAADDDAAA	DDDAADDA					
14	AADDDDAADA	DADAAADADA	AADA				
15	DADDDADDDA	AAADDDDAAA	DDA				
16	DDDADAAAAA	ADADAAADA					
17	DADDAADDAD	AADDDDADAA	ADADDA				
18	DAADAAADDA	DDAAADDDAD	A				
19	DDDDAAAADD	DADDDAADAA	AADA				
20	ADDDDAADAA	DAADDAAADD					
21	AAADDADAAD	DDDADDADAA	A				
22	AAAAAAAAAA	DAAA					
23	DAAAAAAAAA	A					
24	AAA						
PEAK PRICING & QUOTAS SCENARIO							
6							
7	DDDDDDD						
8	DDDDDADDDD	DADDDDD					
9	DDADDDADDD	DDDDAAA					
10	DDAAADDADD	DAAADDDDAA	DADAADDDA				
11	DAADDDAADA	DADADADAAD	DA				
12	ADDAAAADDD	ADADADDAAD	DDA				
13	ADAADADDAA	DAAAADDDDD	D				
14	ADAADAAAAD	DAAADDDDAA	D				
15	ADDDDDAAAD	DAADADDDA					
16	ADDAAAAAAD	DADDDADAD					
17	DAAADADADD	AADAADDAA					
18	DAADDAAAAD	DDDDADAAAA	ADDAA				
19	DADDDADADD	DAAADADAA					
20	ADDDDDAADA	AADADADAAD	ADA				
21	AAADDADDAD	DAADDDADAD	AA				
22	AAAAAAAAAA	ADDAA					
23	AAAAAAAA						
24	AAAAAA						

A: ARRIVAL
B: DEPARTURE

TABLE H-23
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

WASHINGTON, D.C.
(National Airport)

TIME OF DAY	NUMBER OF ARRIVALS AND DEPARTURES						
	BASE CASE SCENARIO						
	10	20	30	40	50	60	
6							
7	DDDDDDDDDA	A					
8	DDDDADADAD	DDDDDDDAAA	ADDA				
9	DDDDAADDAD	DDDADDDAAD	DDDAAAADA				
10	DDDDAAADDA	DADAADDAAA	ADDADDDDAD	DDDDAA			
11	DADDAAAAAA	DDAAAAADAD	DDAAAAADAA	AD			
12	DDDAAAADDA	ADAAADDDDD	AAAADDDAAA	AAAA			
13	DADAAADAAA	DDDDDAAADD	DDDAADDAAA	D			
14	AAADAAAAAA	DAADDDDAAA	DADAAA				
15	ADDDDDDAAD	ADAAAADAAD	DDDDDDA				
16	DAADAAAAAA	DDDDDDADDD	ADDAA				
17	DDÁAAADDDA	DAAAADDDDA	ADADDAAAAD	DDDDDDAA			
18	DAADADADDD	AAADDDADAD	DADDDAADA				
19	DDADDDAAAA	DDADAAADDD	DDDAADADAA	DDDDAAAAAA	AD		
20	DADADDDAAD	DDAAAAADAA	DDDADDDDDA	AA			
21	AADADDDDDA	DAAAADDAAA	DDADDAAA				
22	ADADAAADDA	DDAA					
23	DDAADAAAAD	AAAADAAAA					
24	AAAAA						
	PEAK PRICING & QUOTAS SCENARIO						
6							
7	DDDDDDDDDD	DDDDADD					
8	DDDADDDAAD	DADAADAADD	AADDDDADD				
9	DDADADDAAD	AAADDAADAA	ADDDDD				
10	DAADDADDDA	DDAADADAAD	ADAADDDDAA				
11	DADAAAADDA	AAAADADADD	DADAADDDAA	A			
12	DADADDAADD	DAADDADDAA	DDDDAAADDA				
13	DAAADAAADA	ADDDADAAAD	ADADDAADDA	ADA			
14	DAAADDDDDD	AAADADADAA	DDADDDDDDA	A			
15	ADAAAADDAD	ADDAADDAAA	DAAAADDADD	DAAA			
16	ADDDDADADA	AADADDAADD	AADDDDA				
17	DAAADADDAA	DDDAADAAAA	DDADADDDAA	AA			
18	DAADADDDDA	AAADAADDDA	ADDADDAD				
19	DAAAAAADDA	ADDDDDDAAA	ADDAADDDDA	ADD			
20	DAAADAADAD	DDAAAAADAD	DAADDDAADA				
21	DDDDAAAAAD	AADDDDAADA	DDDDAAADDA	A			
22	DDAAADDDDA	DDAAAAADDD	DAAADAAAAA				
23	AAAAAAAAAA	AAAA					
24	AAAAAAA						

A: ARRIVAL
B: DEPARTURE

APPENDIX I

SCHEDULED FLIGHTS TO OTHER AIRPORTS IN THE 23 CITY NETWORK AS PERCENTAGE OF TOTAL NETWORK OPERATIONS

AIRPORT	PERCENTAGE
ORD	43
BOS	40
SFO	47
STL	50
DEN	39
LAX	45
SEA	30
PHL	52
CLE	58
NYC	52
DCA	62
ATL	48
MSP	44
DTW	55
MCI	39
DFW	42
HLU	23
IAH	47
MIA	40
PIT	44
TPA	54
LAS	46

Source: OAG, June 1, 1975.

APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/27/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #1
BASELINE CONFIGURATION

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ORD	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.0	8.2	8.4	8.8	9.2	9.5	9.9	10.3	11.0	11.7	12.3	13.0	13.7	14.7	15.7	16.7	17.7	18.7
BOS	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.7	1.8	2.0	2.2	2.2	2.3	2.5	2.6	2.7	2.9	3.2	3.4	3.7	3.9
SFO	1.8	1.9	2.1	2.3	2.4	2.6	2.8	3.0	3.1	3.3	4.0	4.8	5.5	6.3	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
STL	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.6	1.1	1.5	2.0	2.5	3.1	3.7	4.3	4.9	5.5	6.5	7.4	8.4	9.3	10.3
DEN	.2	.3	.3	.4	.4	.4	.5	.5	.6	.6	1.1	1.6	2.0	2.5	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.3	6.7	7.1
LAX	.3	.3	.4	.5	.5	.6	.7	.8	.8	.9	1.1	1.3	1.6	1.8	2.0	2.3	2.7	3.0	3.4	3.7	4.8	5.9	7.0	8.1	9.2
SEA	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.3	.5	.8	1.0	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.4	2.7	2.9	3.1
PHL	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.3	.3	.4	.4	.4	.4	.5	.5	.5	.9	1.3	1.6	2.0	2.4
CLE	-	-	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.3	.3	.4	.4	.5	.5	.6	.7	.7	.8	.9
NYC	-	-	-	-	-	-	-	-	-	-	.2	.4	.7	.9	1.1	1.6	2.1	2.6	3.1	3.6	4.9	6.2	7.6	8.9	10.2
DCA	.9	1.0	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.0	3.2	3.4	3.6	3.8	4.1	4.3	4.5
ATL	-	.1	.1	.1	.1	.2	.2	.2	.3	.3	.5	.6	.8	.9	1.1	1.1	1.1	1.1	1.1	1.1	1.4	1.7	2.0	2.3	2.6
MSY	-	-	-	-	-	-	-	-	-	-	.1	.2	.2	.3	.4	.4	.4	.4	.4	.4	.5	.6	.8	.9	1.0
MSP	-	.1	.1	.1	.1	.2	.2	.2	.3	.3	.4	.5	.5	.6	.7	.7	.7	.8	.8	.8	1.0	1.3	1.5	1.8	2.0
DTW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.2	.4	.5	.6
DFW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOT	11.4	12.0	12.7	13.4	14.0	14.7	15.4	16.1	16.7	17.4	20.8	24.3	27.7	31.2	34.6	37.7	40.7	43.8	46.8	49.9	56.6	63.3	70.1	76.8	83.5

APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/27/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #2
QUOTAS & PEAK PRICING
BASELINE CONFIGURATION

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ORD	6.2	5.8	5.4	5.0	4.6	4.3	3.9	3.5	3.1	2.7	3.2	3.6	4.1	4.5	5.0	5.4	5.8	6.1	6.5	6.9	7.1	7.3	7.6	7.8	8.0
BOS	.9	.8	.7	.6	.5	.4	.3	.2	.1	-	.2	.4	.6	.8	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.3
SFO	1.4	1.3	1.1	1.0	.8	.6	.5	.3	.2	-	.2	.4	.5	.7	.9	.9	.9	1.0	1.0	1.0	1.3	1.7	2.0	2.4	2.7
STL	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.3	.4	.5	.6	.7	.8
DEN	.2	.2	.1	.1	.1	.1	.1	-	-	-	.1	.2	.2	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.6	.7
LAX	.2	.2	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	.1	.2	.4	.5	.6	.9	1.2	1.6	1.9	2.2
SEA	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.2	.2	.2
PHL	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1
CLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.2	.2	.2	.2
NYC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.2	.3	.4	.5	.6	.7	.7	.8	.9
DCA	.7	.6	.6	.5	.4	.3	.2	.2	.1	-	.1	.1	.2	.2	.3	.3	.3	.3	.3	.3	.4	.5	.5	.6	.7
ATL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.2	.2	.2
MSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.1	.1	.1
MSP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.2	.2	.2	.2
DTW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1
DFW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOT	9.9	9.1	8.3	7.5	6.7	6.9	5.1	4.3	3.5	2.7	3.7	4.7	5.6	6.6	7.6	8.5	9.3	10.2	11.0	11.9	13.2	14.5	15.8	17.1	18.4

APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/28/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #3
UG3RD CONFIGURATION

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ORD	6.2	5.8	5.5	5.1	4.7	4.3	3.9	3.6	3.2	2.8	3.5	4.2	4.8	5.5	6.2	7.3	8.4	9.4	10.5	11.6	12.3	13.0	13.7	14.4	15.1
BOS	1.0	1.0	.9	.9	.9	.9	.9	.8	.8	.8	.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7
SFO	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.5	1.7	2.0	2.2	2.4	2.5	2.5	2.6	2.6	2.7	3.4	4.1	4.7	5.4	6.1
STL	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.3	.3	.4	.4	.5	.5	.5	.6	.6	.6	.9	1.3	1.6	2.0	2.3
DEN	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1	.2	.3	.4	.5	.6	.7	.7	.8	.8	.9	1.0	1.1	1.3	1.4	1.5
LAX	.2	.2	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	.2	.4	.6	.8	1.0	1.1	1.1	1.2	1.2	1.3
SEA	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.3	.3	.4	.4	.5	.5
PHL	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.2	.3	.3	.4	.5
CLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.2	.3	.3	.3
NYC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.2	.3	.4	.5	.8	1.1	1.5	1.8	2.1
DCA	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.9	1.1	1.2	1.4	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.7	1.7	1.8	1.9
ATL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.3	.3	.4	.4
MSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.3	.3	.4	.4
MSP	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.3	.3	.3	.3	.3	.3	.4	.5	.5	.6	.7
DTW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2
DFW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOT	10.2	9.8	9.3	8.8	8.3	7.9	7.4	6.9	6.5	6.0	7.3	8.7	10.0	11.4	12.7	14.5	16.2	18.0	19.7	21.5	24.2	26.9	29.6	32.3	35.0

APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/28/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #4
QUOTAS & PEAK PRICING
UG3RD CONFIGURATION

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ORD	6.0	5.4	4.8	4.2	3.6	2.9	2.3	1.7	1.1	.5	.4	.3	.2	.1	-	.3	.5	.8	1.0	1.3	1.5	1.7	1.8	2.0	2.2
BOS	.9	.8	.7	.6	.5	.4	.3	.2	.1	-	-	-	-	-	-	.2	.3	.5	.6	.8	.8	.8	.9	.9	.9
SFO	1.4	1.3	1.1	1.0	.8	.6	.5	.3	.2	-	-	-	-	-	-	-	.1	.1	.2	.2	.4	.5	.7	.8	1.0
STL	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.2	.2	.2	.2
DEN	.2	.2	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	.1	.1	.2	.2	.2	.2	.2	.2	.2
LAX	.2	.2	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.2	.2	.2
SEA	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.1	.1	.1
PHL	.1	.1	.1	.1	.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.1	.1	.1
NYC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.2	.2	.3	.3
DCA	.7	.6	.6	.5	.4	.3	.2	.2	.1	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.2	.2	.2
ATL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MSY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MSP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.1	.1	.1	.1	.1	.1	.1	.1
DTW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DFW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HLU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IAH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOT	9.7	8.7	7.6	6.6	5.6	4.6	3.6	2.5	1.5	.5	.4	.3	.2	.1	-	.7	1.3	2.0	2.6	3.3	3.7	4.2	4.6	5.1	5.5

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: ATL

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	.78	0.00	0.00	0.00
1977	1.55	0.00	0.00	0.00
1978	2.33	0.00	0.00	0.00
1979	3.11	0.00	0.00	0.00
1980	3.88	0.00	0.00	0.00
1981	5.31	0.00	0.00	0.00
1982	6.20	0.00	0.00	0.00
1983	7.08	0.00	0.00	0.00
1984	7.97	0.00	0.00	0.00
1985	8.85	0.00	0.00	0.00
1986	14.43	0.00	0.00	0.00
1987	19.45	0.00	0.00	0.00
1988	24.47	0.00	0.00	0.00
1989	29.49	0.00	0.00	0.00
1990	34.51	0.00	0.00	0.00
1991	37.03	.67	1.35	0.00
1992	37.03	1.35	2.69	0.00
1993	37.03	2.02	4.04	0.00
1994	37.03	2.69	5.39	0.00
1995	37.03	3.37	6.73	0.00
1996	51.02	4.37	8.75	0.00
1997	61.95	5.10	10.20	0.00
1998	72.88	5.83	11.66	0.00
1999	83.81	6.56	13.12	0.00
2000	94.74	7.29	14.58	0.00

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: BOS

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	28.24	28.24	28.24	28.24
1976	29.37	25.42	27.68	25.42
1977	30.50	22.59	27.11	22.59
1978	31.63	19.77	26.55	19.77
1979	32.76	16.94	25.98	16.94
1980	33.89	14.12	25.42	14.12
1981	42.74	13.79	30.33	13.79
1982	44.12	10.34	29.64	10.34
1983	45.50	6.89	28.95	6.89
1984	46.88	3.45	28.27	3.45
1985	48.26	0.00	27.58	0.00
1986	55.53	7.21	31.73	0.00
1987	60.58	14.42	34.62	0.00
1988	65.63	21.64	37.50	0.00
1989	70.68	28.85	40.39	0.00
1990	75.73	36.06	43.27	0.00
1991	84.72	39.69	47.32	6.11
1992	89.29	41.21	48.84	12.21
1993	93.87	42.74	50.37	18.32
1994	98.45	44.27	51.90	24.42
1995	103.03	45.79	53.42	30.53
1996	116.16	48.20	57.68	32.40
1997	125.64	48.99	60.06	33.19
1998	135.12	49.78	62.43	33.98
1999	144.61	50.57	64.80	34.77
2000	154.09	51.36	67.17	35.56

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: CLE

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	.52	0.00	0.00	0.00
1977	1.04	0.00	0.00	0.00
1978	1.56	0.00	0.00	0.00
1979	2.08	0.00	0.00	0.00
1980	2.60	0.00	0.00	0.00
1981	3.46	0.00	0.00	0.00
1982	4.03	0.00	0.00	0.00
1983	4.61	0.00	0.00	0.00
1984	5.18	0.00	0.00	0.00
1985	5.76	0.00	0.00	0.00
1986	6.69	0.00	0.00	0.00
1987	7.30	0.00	0.00	0.00
1988	7.91	0.00	0.00	0.00
1989	8.52	0.00	0.00	0.00
1990	9.13	0.00	0.00	0.00
1991	10.76	1.27	1.27	.63
1992	12.03	2.53	2.53	1.27
1993	13.29	3.80	3.80	1.90
1994	14.56	5.06	5.06	2.53
1995	15.82	6.33	6.33	3.16
1996	19.52	6.73	7.40	3.36
1997	22.21	6.73	8.08	3.36
1998	24.90	6.73	8.75	3.36
1999	27.59	6.73	9.42	3.36
2000	30.28	6.73	10.09	3.36

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: DCA

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	20.59	20.59	20.59	20.59
1976	22.65	18.53	20.59	18.53
1977	24.71	16.47	20.59	16.47
1978	26.77	14.41	20.59	14.41
1979	28.83	12.36	20.59	12.36
1980	30.89	10.30	20.59	10.30
1981	37.79	9.45	23.62	9.45
1982	40.15	7.08	23.62	7.08
1983	42.51	4.72	23.62	4.72
1984	44.87	2.36	23.62	2.36
1985	47.23	0.00	23.62	0.00
1986	55.86	1.88	29.50	0.00
1987	61.50	3.77	33.89	0.00
1988	67.15	5.65	38.28	0.00
1989	72.80	7.53	42.68	0.00
1990	78.45	9.41	47.07	0.00
1991	90.42	10.12	50.61	.67
1992	96.50	10.12	50.61	1.35
1993	102.57	10.12	50.61	2.02
1994	108.64	10.12	50.61	2.70
1995	114.72	10.12	50.61	3.37
1996	130.75	13.73	57.07	4.33
1997	138.70	16.62	59.96	5.06
1998	146.65	19.50	62.85	5.78
1999	154.59	22.39	65.74	6.50
2000	162.54	25.28	68.63	7.22

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: DEN

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	5.34	5.34	5.34	5.34
1976	6.41	4.81	5.07	4.81
1977	7.48	4.27	4.81	4.27
1978	8.54	3.74	4.54	3.74
1979	9.61	3.20	4.27	3.20
1980	10.68	2.67	4.00	2.67
1981	13.71	2.49	4.36	2.49
1982	14.95	1.87	4.05	1.87
1983	16.20	1.25	3.74	1.25
1984	17.44	.62	3.43	.62
1985	18.69	0.00	3.11	0.00
1986	34.59	2.56	6.41	0.00
1987	49.97	5.12	9.61	0.00
1988	65.34	7.69	12.81	0.00
1989	80.72	10.25	16.01	0.00
1990	96.09	12.81	19.22	0.00
1991	117.13	13.78	22.74	1.38
1992	130.91	13.78	24.80	2.76
1993	144.69	13.78	26.87	4.13
1994	158.47	13.78	28.94	5.51
1995	172.25	13.78	31.00	6.89
1996	193.87	16.45	36.49	7.15
1997	208.90	18.60	40.78	7.15
1998	223.92	20.75	45.07	7.15
1999	238.94	22.89	49.36	7.15
2000	253.97	25.04	53.65	7.15

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: LAX

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	5.93	5.93	5.93	5.93
1976	8.01	5.34	5.34	5.34
1977	10.08	4.75	4.75	4.75
1978	12.16	4.15	4.15	4.15
1979	14.24	3.56	3.56	3.56
1980	16.31	2.97	2.97	2.97
1981	22.31	2.88	2.88	2.88
1982	24.83	2.16	2.16	2.16
1983	27.35	1.44	1.44	1.44
1984	29.87	.72	.72	.72
1985	32.39	0.00	0.00	0.00
1986	42.19	0.00	0.00	0.00
1987	50.48	0.00	0.00	0.00
1988	58.77	0.00	0.00	0.00
1989	67.05	0.00	0.00	0.00
1990	75.34	0.00	0.00	0.00
1991	91.26	4.68	7.80	.78
1992	104.52	9.36	15.60	1.56
1993	117.78	14.04	23.40	2.34
1994	131.04	18.72	31.20	3.12
1995	144.30	23.40	39.00	3.90
1996	196.85	37.73	43.47	4.92
1997	241.96	50.85	45.93	5.74
1998	287.07	63.98	48.39	6.56
1999	332.18	77.10	50.85	7.38
2000	377.29	90.22	53.31	8.20

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MCI

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00
1986	0.00	0.00	0.00	0.00
1987	0.00	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00
1990	0.00	0.00	0.00	0.00
1991	0.00	0.00	0.00	0.00
1992	0.00	0.00	0.00	0.00
1993	0.00	0.00	0.00	0.00
1994	0.00	0.00	0.00	0.00
1995	0.00	0.00	0.00	0.00
1996	3.89	.65	1.30	0.00
1997	7.78	1.30	2.59	0.00
1998	11.67	1.95	3.89	0.00
1999	15.57	2.59	5.19	0.00
2000	19.46	3.24	6.49	0.00

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MSP

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	.82	0.00	0.00	0.00
1977	1.63	0.00	0.00	0.00
1978	2.45	0.00	0.00	0.00
1979	3.27	0.00	0.00	0.00
1980	4.08	0.00	0.00	0.00
1981	5.82	0.00	0.00	0.00
1982	6.79	0.00	0.00	0.00
1983	7.76	0.00	0.00	0.00
1984	8.73	0.00	0.00	0.00
1985	9.70	0.00	0.00	0.00
1986	12.63	0.00	1.99	0.00
1987	15.29	0.00	3.99	0.00
1988	17.95	0.00	5.98	0.00
1989	20.61	0.00	7.98	0.00
1990	23.27	0.00	9.97	0.00
1991	25.13	1.40	10.47	.70
1992	25.83	2.79	10.47	1.40
1993	26.52	4.19	10.47	2.09
1994	27.22	5.58	10.47	2.79
1995	27.92	6.98	10.47	3.49
1996	38.74	7.45	14.15	3.72
1997	47.68	7.45	17.13	3.72
1998	56.62	7.45	20.11	3.72
1999	65.56	7.45	23.09	3.72
2000	74.50	7.45	26.07	3.72

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MSY

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00
1986	2.41	0.00	0.00	0.00
1987	4.82	0.00	0.00	0.00
1988	7.23	0.00	0.00	0.00
1989	9.64	0.00	0.00	0.00
1990	12.05	0.00	0.00	0.00
1991	12.84	.64	1.28	0.00
1992	12.84	1.28	2.57	0.00
1993	12.84	1.93	3.85	0.00
1994	12.84	2.57	5.13	0.00
1995	12.84	3.21	6.42	0.00
1996	17.59	3.38	8.12	0.00
1997	21.64	3.38	9.47	0.00
1998	25.70	3.38	10.82	0.00
1999	29.76	3.38	12.18	0.00
2000	33.82	3.38	13.53	0.00

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: NYC

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	0.00	0.00	0.00	0.00
1976	0.00	0.00	0.00	0.00
1977	0.00	0.00	0.00	0.00
1978	0.00	0.00	0.00	0.00
1979	0.00	0.00	0.00	0.00
1980	0.00	0.00	0.00	0.00
1981	0.00	0.00	0.00	0.00
1982	0.00	0.00	0.00	0.00
1983	0.00	0.00	0.00	0.00
1984	0.00	0.00	0.00	0.00
1985	0.00	0.00	0.00	0.00
1986	8.66	0.00	0.00	0.00
1987	17.32	0.00	0.00	0.00
1988	25.98	0.00	0.00	0.00
1989	34.65	0.00	0.00	0.00
1990	43.31	0.00	0.00	0.00
1991	66.58	4.16	4.16	.83
1992	87.38	8.32	8.32	1.66
1993	108.19	12.48	12.48	2.50
1994	128.99	16.64	16.64	3.33
1995	149.80	20.80	20.80	4.16
1996	208.26	24.55	34.71	5.93
1997	264.14	27.94	48.26	7.62
1998	320.01	31.32	61.80	9.31
1999	375.89	34.71	75.35	11.01
2000	431.77	38.10	88.89	12.70

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: ORD

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	182.62	182.62	182.62	182.62
1976	187.60	171.83	172.11	165.74
1977	192.58	161.04	161.59	148.86
1978	197.56	150.25	151.08	131.99
1979	202.54	139.46	140.56	115.11
1980	207.52	128.67	130.05	98.23
1981	256.05	142.03	144.03	98.02
1982	262.05	129.03	131.36	77.68
1983	268.05	116.02	118.69	57.34
1984	274.05	103.02	106.02	37.01
1985	280.06	90.02	93.35	16.67
1986	308.09	110.88	122.11	14.04
1987	321.42	127.03	145.97	10.53
1988	334.76	143.17	169.84	7.02
1989	348.09	159.31	193.70	3.51
1990	361.43	175.45	217.56	0.00
1991	409.22	200.51	271.33	9.69
1992	434.57	214.68	311.58	19.38
1993	459.91	228.84	351.83	29.07
1994	485.26	243.00	392.08	38.76
1995	510.60	257.16	432.33	48.45
1996	578.89	280.39	484.37	58.28
1997	618.27	289.05	511.94	65.37
1998	657.65	297.71	539.51	72.46
1999	697.03	306.38	567.07	79.55
2000	736.41	315.04	594.64	86.64

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: PHL

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	2.62	2.62	2.62	2.62
1976	2.89	2.36	2.36	2.36
1977	3.15	2.10	2.10	2.10
1978	3.41	1.84	1.84	1.84
1979	3.67	1.57	1.57	1.57
1980	3.94	1.31	1.31	1.31
1981	4.76	1.19	1.19	1.19
1982	5.06	.89	.89	.89
1983	5.36	.60	.60	.60
1984	5.66	.30	.30	.30
1985	5.95	0.00	0.00	0.00
1986	7.52	0.00	0.00	0.00
1987	8.78	0.00	0.00	0.00
1988	10.03	0.00	0.00	0.00
1989	11.29	0.00	0.00	0.00
1990	12.54	0.00	0.00	0.00
1991	13.91	0.00	.66	0.00
1992	14.57	0.00	1.32	0.00
1993	15.24	0.00	1.99	0.00
1994	15.90	0.00	2.65	0.00
1995	16.56	0.00	3.31	0.00
1996	29.29	.67	5.99	0.00
1997	41.93	1.33	8.65	0.00
1998	54.58	2.00	11.32	0.00
1999	67.23	2.66	13.98	0.00
2000	79.87	3.33	16.64	0.00

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: SFO

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	45.52	45.52	45.52	45.52
1976	50.36	40.97	44.67	40.97
1977	55.19	36.42	43.81	36.42
1978	60.03	31.86	42.96	31.86
1979	64.87	27.31	42.11	27.31
1980	69.70	22.76	41.25	22.76
1981	89.24	21.80	48.37	21.80
1982	95.03	16.35	47.34	16.35
1983	100.82	10.90	46.32	10.90
1984	106.61	5.45	45.30	5.45
1985	112.40	0.00	44.28	0.00
1986	144.79	6.45	54.48	0.00
1987	171.32	12.90	62.36	0.00
1988	197.84	19.35	70.25	0.00
1989	224.36	25.80	78.13	0.00
1990	250.88	32.26	86.02	0.00
1991	267.40	35.14	93.97	1.53
1992	267.40	35.91	96.26	3.06
1993	267.40	36.67	98.56	4.58
1994	267.40	37.44	100.85	6.11
1995	267.40	38.20	103.14	7.64
1996	277.83	53.18	134.15	14.29
1997	277.83	66.68	161.14	20.64
1998	277.83	80.17	188.13	26.99
1999	277.83	93.67	215.12	33.34
2000	277.83	107.16	242.11	39.69

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: SEA

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	2.60	2.60	2.60	2.60
1976	2.60	2.34	2.34	2.34
1977	2.60	2.08	2.08	2.08
1978	2.60	1.82	1.82	1.82
1979	2.60	1.56	1.56	1.56
1980	2.60	1.30	1.30	1.30
1981	2.95	1.18	1.18	1.18
1982	2.95	.89	.89	.89
1983	2.95	.59	.59	.59
1984	2.95	.30	.30	.30
1985	2.95	0.00	0.00	0.00
1986	10.13	0.00	0.00	0.00
1987	17.10	0.00	0.00	0.00
1988	24.06	0.00	0.00	0.00
1989	31.03	0.00	0.00	0.00
1990	37.99	0.00	0.00	0.00
1991	46.28	.68	2.04	.68
1992	51.73	1.36	4.08	1.36
1993	57.17	2.04	6.13	2.04
1994	62.62	2.72	8.17	2.72
1995	68.06	3.40	10.21	3.40
1996	77.34	4.18	11.85	3.48
1997	85.01	4.88	13.24	3.48
1998	92.67	5.57	14.63	3.48
1999	100.34	6.27	16.03	3.48
2000	108.00	6.97	17.42	3.48

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: STL

	ANNUAL COST			
	SCENE 1	SCENE 2	SCENE 3	SCENE 4
1975	2.64	2.64	2.64	2.64
1976	2.64	2.37	2.90	2.37
1977	2.64	2.11	3.16	2.11
1978	2.64	1.85	3.43	1.85
1979	2.64	1.58	3.69	1.58
1980	2.64	1.32	3.95	1.32
1981	2.91	1.16	4.66	1.16
1982	2.91	.87	4.95	.87
1983	2.91	.58	5.24	.58
1984	2.91	.29	5.53	.29
1985	2.91	0.00	5.82	0.00
1986	17.65	0.00	7.91	0.00
1987	32.26	0.00	9.74	0.00
1988	46.86	0.00	11.56	0.00
1989	61.47	0.00	13.39	0.00
1990	76.07	0.00	15.21	0.00
1991	94.24	1.82	15.81	1.22
1992	112.48	3.65	16.42	2.43
1993	130.72	5.47	17.02	3.65
1994	148.96	7.30	17.63	4.86
1995	167.20	9.12	18.24	6.08
1996	204.78	12.68	29.80	6.34
1997	235.21	15.85	40.58	6.34
1998	265.65	19.02	51.35	6.34
1999	296.08	22.19	62.13	6.34
2000	326.51	25.36	72.91	6.34

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

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